

T H E
P H I L O S O P H Y
O F
N A T U R A L H I S T O R Y.

B Y
W I L L I A M S M E L L I E,
MEMBER OF THE ANTIQUARIAN AND ROYAL SOCIETIES
OF EDINBURGH.

I N T W O V O L U M E S.
V O L. I I.

D U B L I N:

Printed by William Porter,

FOR CHAMBERLAIN AND RICE, W. WILSON, P. WOGAN, L. WHITE,
P. BYRNE, W. MC. KENZIE, J. MOORE, GRUEBER AND MC. AL-
LISTER, W. JONES, R. WHITE, and J. MILLIKEN.

M.DCC.XC.



CONTENTS.

CHAP. X.

	Page.
<i>Of Puberty—Its symptoms and effects in</i>	
<i>different animals - - -</i>	1

CHAP. XI.

<i>Of Love—Its expressions and effects in dif-</i>	
<i>ferent animals—Pairing—Seasons—</i>	
<i>Parental affection - - -</i>	9

CHAP. XII.

<i>Of the Transformation of Animals--Trans-</i>	
<i>formation of the caterpillar tribes—of</i>	
A 2	<i>frogs,</i>

iv C O N T E N T S.

	Page.
<i>frogs, &c.—All animals undergo changes in their form and aspect—What are the probable intentions of Nature in changing forms</i>	36

C H A P. XIII.

<i>Of the Habitations of Animals—Their different modes of constructing abodes for warmth and protection to themselves and their offspring—The form and manner of their habitations accommodated to the exigencies of the animal</i>	75
---	----

C H A P. XIV.

<i>Of the Hostilities of Animals—Why animals prey upon one another, but seldom on their own species—Advantages derived from this seemingly destructive institution of Nature</i>	184
--	-----

C H A P.

C O N T E N T S. v

C H A P. XV.

	Page.
<i>Of the Artifices of animals in catching their prey and escaping their enemies—</i>	
<i>These artifices are, in general, purely instinctive; but some animals can vary their mode of attack or defence according to particular circumstances and situations</i>	226

C H A P. XVI.

<i>Of the Society of Animals—What are the motives and advantages of it—Gregarious tribes—Whether man belongs to this tribe—Society of two kinds</i>	252
---	-----

C H A P. XVII.

<i>Of the Docility of Animals—How far improveable by culture—Effects of domestication</i>	287
---	-----

CHAP.

vi C O N T E N T S.

C H A P. XVIII.

	Page.
<i>Of the Characters and Dispositions of Animals—Rapacious—mild—timid—bold—generous</i>	335

C H A P. XIX.

<i>Of the Principle of Imitation in Animals—Is the nearest approach to reasoning and language</i>	343
---	-----

C H A P. XX.

<i>Of the Migration of Animals—More general than commonly believed—The probable motives which induce animals to migrate</i>	350
---	-----

C H A P. XXI.

<i>Of the Longevity and Death of Animals—A comparative view of animals with regard</i>	to
--	----

C O N T E N T S. vii

	Page.
<i>to the duration of life, and its conse-</i>	
<i>quences - - - -</i>	401

C H A P. XXII.

<i>Of the Progressive Scale of Animals—stops</i>	
<i>at man, and why—In this world, it ap-</i>	
<i>pears to be impossible that a being superior</i>	
<i>to man, could exist—Reasons for this opi-</i>	
<i>nion - - - - - -</i>	427

THE



T H E
P H I L O S O P H Y
O F
N A T U R A L H I S T O R Y.

C H A P T E R X.

Of the Puberty of Animals.

THE puberty of animals commences at that period of their existence when Nature endows them with the power of multiplying the species. This period is as various as the different tribes of animals. In some it arrives sooner, in others later; but, in every animal, it is accompanied with some remarkable changes in constitutions and affections. From infancy to puberty there is a gradual increase of size; but, immediately after that period, in both sexes, the growth of the body makes a sudden spring, and acquires redoubled strength and activity. The growth of animals, however, does not always stop at the age of puberty. Men, quadrupeds, and

VOL. II. B fishes,



fishes, continue to grow for some time after their capacity of multiplying. But most birds and insects seem to acquire their full dimensions before they arrive at the age of puberty.

Before puberty, the voice of a man, like that of a woman, is shrill and feeble. But, after that period, it becomes rough and strong. This effect is produced by some unaccountable and sudden change in the organs of speech, which is not confined to the human species; for the voice of a horse or a bull is deeper after than before puberty. In eunuchs, no such alteration of voice is to be observed; for their voice, though shrill and piercing, can never produce a low or deep note. At this period, too, that distinguishing characteristic of man, the beard, begins to appear, together with other external and internal changes, which it is unnecessary to relate. But eunuchs are totally destitute of beards. These two facts indicate a connection which merits the attention of philosophers.

With regard to the female sex, they are by no means exempted from constitutional changes when they arrive at the age of puberty. The alteration in the tone of their voice, if it does happen, is hardly perceptible. Neither are their faces deformed by a beard,



a beard, which, according to our present ideas, would have a disgusting effect. At this period, however, their mammae swell, and a periodical evacuation takes place, which produces wonderful revolutions in their constitution and affections. In both sexes, the mental changes are not less remarkable than the corporeal. The powers of the mind expand, the force of genius is felt, and very different objects solicit attention: Instead of puerile amusements, ambition, a warm and unaffected friendship, a generosity and unsuspecting demeanour, both in words and actions, are the almost universal characteristics of this period of human life. I mention it with pleasure, that, as far as my observation extends, in youth, unless they are corrupted by example, by neglect, or by other causes, all men are honest, friendly, generous, and humane. If this remark be true, Nature is fully exculpated. But, when a young man enters into the business of life, his candour and ingenuousness soon meet with a shock. This is the painful reverse. Instead of liberality and integrity of conduct, he has to encounter with selfishness, chicane, and too often with direct villainy. This unhappy discovery turns his thoughts into a

different current, contracts the noble openness of his heart, renders him suspicious and guarded, and, if he shall chance to retain his integrity, he is obliged to assume, at least, the appearance of jealousy and deceit. I by no means intend this to be the universal character of mankind; I only lament that it is too general.

In every race of mankind of which we have any knowledge, the females arrive sooner at puberty than the males. But the age of puberty differs in different countries. This difference seems to originate from two causes, the temperature of the climate, and the quality of the food. Children of citizens, and of opulent parents, who are fed with rich and nourishing victuals, arrive sooner at this state. Children, on the contrary, brought up in the country, or whose parents are poor, require two or three years longer; because their food is not only coarse, but too sparingly given. In the southern regions of Europe, and in large cities, the females arrive at puberty about the age of twelve, and the males about fourteen. But, in northern climates, and in the country, girls hardly come to maturity till they are fourteen, and boys not before sixteen. In the warmest regions of Asia,
Africa,

Africa, and America, the age of puberty in females commences at ten, and sometimes at nine.

After puberty, the Count de Buffon remarks, ' marriage is the natural state of man. ' A man ought to have but one wife, and a ' woman but one husband. This is the law ' of Nature; for the number of females is ' nearly equal to that of the males. Such ' laws as have been enacted in opposition to ' this natural principle, have originated solely ' from tyranny and ignorance. Reason, hu- ' manity, and justice, revolt against those ' odious seraglios, in which the liberty and ' the affections of many women are sacrificed ' to the brutal passion of a single man. Does ' this unnatural pre-eminence render those ' tyrants of the human race more happy? ' No! Surrounded with eunuchs, and with ' women who are useless to themselves and to ' other men, they are tormented with the ' constant appearance of that accumulated ' load of misery they have created.'

All animals, as well as those of the human species, undergo, at the age of puberty, similar changes in the form of their bodies, and in the dispositions of their minds. From mild, placid, and gentle, they become bold, restless,

restless, and ungovernable. Their bodies are then, in strength and symmetry, perfectly accommodated to the new sentiments which Nature, for wise purposes, excites in their minds. In the deer kind, the horns of the males appear not till they are fit for multiplying the species. At this period, the crest, the wattles, and the plumage of the male gallinaeous birds acquire additional beauty, and their courage and strength are greatly augmented. The pigeon, instead of being querulous, timid, and voracious, whenever the age of puberty arrives, feels emotions of a very different kind. Conscious of the new vigour he has acquired, he assumes a bold and important air. He struts about with a majestic pride, and immediately addresses, with all the gaiety of a lover, some favourite female, whom he solicits with the most assiduous gallantry and attention. After the coy female gives her assent, their after-conduct exhibits such a mutual and ardent affection, and such a constant fidelity, as afford no inconsiderable pattern to the human species.

With regard to fishes, we are totally ignorant of the periods when the different tribes of them acquire the power of multiplying. From the element they inhabit, from the rapidity of their

their motions, and from their desultory and wandering mode of living, we are equally ignorant of many other important parts of their œconomy and manners. This continues to be an ample field for future investigation, and highly worthy of the attention of naturalists.

The œconomy and manners of insects are more open to inspection. Those of the winged tribes undergo many changes, both in figure and structure, before they arrive at the age of puberty. They first escape from the eggs in the form of minute caterpillars. In this state they are exceedingly voracious, and grow with rapidity to their full size ; but they are destitute both of the power and of the organs necessary for the multiplication of the species. They are next transformed into chrysalids : In this state, their bodies are covered with a kind of crust or shell, from which the animals have again to escape, as from a second egg. In this imprisoned condition, they remain during a longer or shorter period, according to the species, or to the season of the year in which they are transformed. After their transformation into flies, they burst this crust or shell, and appear in the form of flies, furnished with wings, legs, feelers, &c. of all which they were destitute

destitute in their former state. When transformed into flies, caterpillars have arrived at the age of puberty. They are now perfect animals, and endowed with the faculty of transmitting a numerous progeny to posterity.

CHAP.

CHAPTER XI.

Of Love.

THE great intention of Nature, in endowing almost every animal with a sexual attachment, is the multiplication and continuation of the respective species. But, with regard to man, and, in an inferior degree, to all pairing animals, love is the source of many other social and important advantages. Love, or a strong affection for a particular woman, is to young men, perhaps, one of the greatest incentives to virtue and propriety of conduct. In northern countries, it seldom rises to that degree of frenzy, which, in warmer climates, not only engrosses the whole attention, but often totally unhinges the powers of the mind. In northern regions, however, it occupies more gently the imagination, gives a cheerfulness and alacrity to the business or studies of life, and, if reciprocal, diffuses over the mind and body a placid happiness, and a tranquillity of disposition, which greatly contribute to the health and vigour of both. A
young

young man in love thinks that the eyes of his favourite continually behold him. Through this amiable medium he views all his actions, and even his thoughts. His affection and veneration are so great, that he is in some measure deterred from regarding any other woman, and what is of more importance, from indulging any loose or irregular appetite. The dispositions and affections of the female are the same with those of the male. Her attention is completely engrossed: and she never thinks or dreams of any man, but of him who is the object of her affection. A young man and a young woman in love exhibit the most innocent and the most amiable picture of human nature. Actuated by no interested motives, and regardless of future contingencies, they obey the supreme command of Nature. How much is it to be lamented, that, from the cruel, but perhaps unavoidable institutions and customs of civil societies, it is so often not only prudent, but necessary, to check, and even to overcome, this powerful law of Nature?

Many are the advantages that mankind derive from society and regular governments, and we should cheerfully submit to those hardships and inconveniencies to which they

they give rise. But every man, however submissive to the laws of his country, must regret that necessity which makes them oppose any of the laws of Nature, and especially the almost irresistible law of love.

In the present state of society, it must be acknowledged, early marriages, among people in the ordinary and dependant ranks of life, are extremely hazardous. When both parties are industrious and oeconomical, such marriages are not only the most natural, but are productive of the greatest happiness and cordiality. But the reverse is dreadful! Children, straitened circumstances, resentment of parents, whether real or affected, too often produce all the complicated miseries to which mankind, in their lowest state of degradation, can be subjected. Among this order of men, therefore, it is of the highest importance that the law of Nature should yield, for some time at least, to the institutions of society, and to those prudential motives which parents learn from experience to be ingredients essential to the comfort and happiness of life.

Men of fortune and of opulence have it in their power to obey the laws of Nature and of love; and some examples, though few in number, occasionally happen of rich men
acting

acting a disinterested part in their matrimonial engagements. Instead of following the dictates of Nature, many men of fortune and independence, disregarding the high privilege they enjoy, sacrifice their taste, their passion, and often their happiness during life, at the shrine of Gold. To accomplish this sordid end, they often embrace deformity, disease, ignorance, peevishness, and every thing that is disgusting to human nature. Let such individuals suffer their punishment. But what are the consequences to the public? Men of rank, in all nations and governments, not only regulate, in a great measure, the manners of their inferiors, but are the natural guardians of the state. For these important purposes, their minds should be noble, generous, and bold; and their bodies should be strong, masculine, fit to encounter the fatigues of war, and to repel every hostile assault that may be made upon their country. But, when men of this description, whatever be their motives, intermarry with weak, deformed, puny, or diseased females, their progeny must of necessity degenerate. The strength, beauty, and symmetry of their ancestors are, perhaps, for ever lost. What is still more to be regretted, debility of body
is

is almost universally accompanied with weakness of mind. Thus, by the avarice, ambition, or inattention, of one individual, a noble and generous race is completely destroyed. By reversing this conduct, it is true, the breed may again be mended; but, to repair a single breach, many generations, endowed with prudence and circumspection, will be requisite. A successive degeneration, however, is an infallible consequence of imprudent or interested marriages of this kind. One puny race may for some time be succeeded by another, till at last their constitutions become so feeble that the animals lose the faculty of multiplying their species. This gradual degeneration is one great cause of the total extinction of conspicuous and noble families. That it should be so, is a wise and beneficent institution of Nature; for, if such debilitated races were continued, a universal degeneration would soon take place, and mankind would be unable to perform the duties, or to undergo the labours of life. Nature first chastises, and at last extirpates, all those who act contrary to her established laws.

Beside the pleasures resulting from society, and from mutual attachment in man, and
in

in pairing animals, the natural love of offspring is a source of the most engaging endearments. The innocent and helpless condition of infants call forth our pity and protection. When a little farther advanced, their beauty, their smiles, and their sprightliness, excite the most agreeable emotions. In their progress from infancy to manhood, we observe with pleasure the unfolding of their mental powers. They imitate our actions long before they can express their desires, or their wants, by language. Their attempts in the acquisition of language are extremely curious and amusing. Their first system of grammar consists entirely of substantive nouns. It is long before they learn the use of adjectives or of copulatives, and still longer before they employ the verb. Their speeches are short, awkward, and blundering; but they are animated, and uttered with astonishing force and vivacity of expression in their eyes, and in the gestures of their bodies. At this period of life, children are solely actuated by Nature and imitation. After they acquire words sufficient for conveying the few ideas they possess, they begin to reason, or rather to employ the language of reasoning; for, at this period of life, children,
when

when they mean to give a reason why they should have any indulgence or gratification, almost universally argue against themselves, and employ a reason why their desires should not be granted. This ridiculous mode of reasoning excites laughter, and affords pleasure and amusement to the parents. It likewise shows, that our first attempt toward reasoning is principally, if not solely, the effect of imitation; for the reasoning power, at this period, is not fully unfolded, because many human instincts, or mental qualities, have not yet been called forth into action. But here I must stop. To do justice to this interesting subject would require volumes.

The love of offspring, which, though not universal, is perhaps the strongest and most active principle in human nature. It overcomes the sense of pain, and sometimes even the principle of self-preservation. A remarkable and a melancholy example of the strength of parental affection was lately exhibited, and, for the honour of our species, deserves to be recorded. In the beginning of January 1786, the *Halfewell* East Indiaman, Captain Richard Pierce, was unfortunately wrecked on the coast of Dorsetshire. Beside several other ladies, Captain Pierce had two of his
OWN

own daughters on board. When the ship was in the extremity of danger, some of the company, by swimming, and other feats of activity, got upon a rock. In this dreadful situation, Captain Pierce asked Mr. Rogers, his third mate, if any plan could be devised for saving the ladies? Mr. Rogers replied, 'It is impossible! but you may save yourself.' Upon which the Captain, addressing himself to his daughters, and enfolding them in his arms, said, 'Then, my dear children, we shall not part; we shall perish together!' Mr. Rogers quitted the ship and reached the rock: An universal shriek of despair was heard, in which the voices of female distress and horror were lamentably distinguishable. In a few moments all was hushed; the ship, with every person on board, had then gone to the bottom. Parents cheerfully submit to the hardest labour, and expose themselves to the greatest dangers, in order to procure nourishment to their young, or to protect them from injury.

A bitch, during the operation of dissection, licked her young, whose presence seemed to make her forget the most excruciating tortures; and, when they were removed, she uttered

uttered the most dolorous cries. Certain species of spiders inclose their eggs in a silken bag spun and wove by themselves. This bag they fix to their back, and carry it along with them wherever they go. They are extremely nimble in their motions. But, when the bag is forced from a spider of this kind, her natural agility forsakes her, and she falls into a languid state. When the bag is again presented to her, she instantly seizes it, and carries it off with rapidity. The young spiders no sooner escape from the eggs than they dexterously arrange themselves on the back of the mother, who continues for some time to carry them about with her, and to supply all their wants. Another species of spider attaches her bag of eggs to her belly. This spider is likewise very agile, and so ferocious and determined in the protection of her eggs, that she has been known to suffer death rather than relinquish them. The deer spontaneously presents herself to be chased by the dogs, to prevent them from attacking her fawn. When the fox perceives that her young have been disturbed in her absence, she carries them off, one after another, and conceals them in a new retreat. Wasps

feed their young, when in the worm or caterpillar state, in the same manner as pigeons and other birds that disgorge. The pigeon, after swallowing grain, retains it for some time in her stomach, till it is softened and macerated: She then disgorges, and throws it into the mouths of her young. 'In the same manner,' says Reaumur, 'I have observed a female wasp swallow a large portion of an insect: In a short time afterwards, she traversed the different cells of her nest, disgorged the contents of her stomach, and distributed food in this half-digested form to her young worms*.

All animals, man perhaps not excepted, acquire a double portion of force and courage after they bring forth. A cow, at least in a domestic state, is a placid and plegmatic animal: But, whenever she produces a calf, a wonderful change is exhibited: She instantly becomes vigilant, active, and even ferocious, in the defence of her young. A lioness deprived of her cubs presents the most dreadful picture of anxiety, rage, and rapacity. Descending lower in the scale of

* Reaumur, tom. II, page 230. 12mo edit.

animation, the same change is to be remarked. A domestic hen is a timid, indocile, and obstinately stupid creature. Though chased, harrassed, and even put in danger of her life, fifty times in a day, she never learns to avoid a garden, or any particular place which she is accustomed to frequent, or to which she is led by her appetite for food. But, the moment her chickens are hatched, instead of her usual timidity, she becomes as bold as a lion. When she thinks her young are in danger, she bristles up her feathers, assumes a fierceness in her eye, makes an alarming noise, and attacks, in the most furious manner, and without distinction, every animal that comes near her. By the suddenness of her onsets, she often alarms men, and actually intimidates and beats off dogs and other animals that could devour her in an instant.

Though several of the insect tribes discover a strong attachment to their young, yet all those which undergo transformations, and do not form societies, must be completely ignorant of the existence of their progeny; because, in general, the parents die before the young are hatched. Nature, however,

has endowed those species with an instinct which produces all the effects of parental affection: They uniformly deposit their eggs in substances which afford to the young, immediately after their escape from the egg, a nourishment adapted to their respective constitutions, and a comfortable and safe protection from injury. Thus Nature, ever attentive to the continuation and happiness of her productions, however seemingly insignificant in the scale of being, often employs very different means to accomplish the same beneficent purposes.

Nature has unquestionably attached pleasure to all the necessary functions of animals. But this pleasure cannot be considered as the original cause of any particular action; for the experiment must be made before the animal can discover whether the result is to be agreeable or disagreeable. The truth is, that Nature has bestowed on the minds of all animated creatures a number of laws or instincts perfectly accommodated to the species, and which irresistibly compel them to perform certain actions. The effects of these laws we perceive: But the causes, or the modes by which they operate on animal minds, are inscrutable.

inscrutable. We may and must admire, but we can never penetrate, the mysteries of Nature.

Bonnet, and some other naturalists, imagine they are exhibiting the causes of that strong and mutual attachment between parents and their offspring, when they tell us, that, in man, and quadrupeds, and birds, the mother is fond of her young, because their natural actions give rise to agreeable sensations; that, from the structure of the mammae, a gentle, but pleasant sensation, is excited by the action of sucking; that the mother is often incommoded by too great a quantity of milk, and that sucking relieves her; that the young love their mother, because she feeds, protects, and communicates to them a cherishing warmth; that, among the feathered tribes, and particularly those which sit upon their young, by the gentle motions of their little ones, an agreeable sensation is excited in the belly of the mother, which is then frequently deprived of feathers. All these sources of reciprocal pleasure may be true: But still they are only effects, and not original causes, of filial and parental affection; for that mutual attachment exists the moment after the
young

young animals come into the world, and, of course, previous to all experience of titillation, of heat, of habit, or of any other circumstances that may, perhaps, contribute to strengthen or prolong the exertion of the primary cause, which must remain for ever concealed from human penetration.

In most animals, except the human species, parental and filial affection cease whenever the young are able to provide for themselves. The pleasures derived from sucking, and from other circumstances formerly mentioned, might for some time remain; but the young grow large, unwieldy, petulant, and enter into competitions for food, which not only contribute to alienate the affection of the parents, but even to excite resentment and aversion. These, however, are only secondary causes. The purposes of Nature are fulfilled. The ardour of affection, which was indispensably necessary to the protection and rearing of the young, being now no longer useful, is so totally extinguished, that neither the parents nor the offspring are capable of recognizing one another. This temporary and amiable instinct is obliterated, and never revives till the fervours
of

of love are again felt, and a new progeny appear.

Marriage or pairing, though by no means an universal institution of Nature, is not unfrequently exhibited in the animal creation. With regard to man, both male and female are instinctively impelled to make a selection. The force of this natural impulse is strongly felt by every young and uncorrupted individual. When not restrained by necessity, or other powerful motives, men and women would intermarry long before it would be prudent in civilized or artificial states of society. This universal, and almost irresistible impulse of selection, is to me the strongest argument in favour of monogamy, or the union of pairs, among the human species.

The same impulse, or law of Nature, takes place among many other animals, as the partridge tribes, the swallow, the linnet, and in general, all the small birds. The assiduity, attention, mutual affection, laborious vigilance, and steadfast fidelity of pairing animals, are truly admirable, and, to ingenious minds, afford the most exemplary admonitions to virtue and conjugal attachment.

Beside

Beside this forcible impulse of selection implanted by Nature in man, and in every other pairing animal, some other facts deserve to be noticed. In all pairing animals, including, of course, the human race, the males and females produced are nearly equal. This is a plain indication that Nature destined these animals to pair, or to marry. Injustice, jealousy, animosity, and every animal calamity, would ensue, if this order of Nature were encroached upon in creatures who are endowed with the instinct of sexual selection.

It is not incurious to remark, that human institutions often contradict the laws of Nature. The dunghill cock and hen, in a natural state, pair. In a domestic state, however, the cock is a jealous tyrant, and the hen a prostitute. But, even in this unnatural society, a selection is sometimes to be observed. The same phenomenon is exhibited among mankind, when placed in certain situations. Like domestic poultry, the Turks, and some Asiatic and African nations, influenced by an accursed government, and by an execrable religion, rebel against the law of love, and of reciprocal attachment. In these countries, a rich man not only engrosses,
but

but imprisons and tortures, as many beautiful women as his fortune enables him to support. "Destitute of all those endearments which arise from mental communication, from parental tenderness and affection, from mutual confidence and solace, he is, while young, perpetually tormented with jealous apprehensions. As he advances in life, his jealousy and his terror augment. Though his females are scrupulously guarded from every intrusion, by servile and mutilated wretches, his fears increase with his years and debility, till a premature and comfortless old age puts a period to his insignificant and listless existence.

In general, it is to be remarked, that all those species of animals, whose offspring require, for some time, the industry and support of both parents, are endowed with the instinct of selection, or of pairing. With regard to the feathered tribes, pairing is almost universal. A distinction, however, as to the duration and circumstances of their pairing, is to be observed. The young of all the small birds, as well as of most of the larger kinds, continue for some weeks in a weak and helpless condition. The mother is
not,

not, like quadrupeds, provided with organs fitted to secrete milk ; of course, she is unable to nourish them out of her own body. She is therefore obliged to go abroad in quest of food for them. But the progeny are so numerous, that all her industry, if not assisted by the father, would be ineffectual for their support and protection. In all birds whose young are in this condition, the males and females not only pair, but each of them is endowed with the strongest parental affection. Both are equally anxious and industrious in procuring food for their mutual offspring. This parental care and attachment uniformly continues till the young are fledged, and have acquired sufficient strength to provide for themselves. Eagles, and some other birds of prey, continue faithfully in pairs for years, and perhaps during life. These facts afford a strong argument in favour of marriage among mankind. No animal remains so long in the infant and helpless state as the children of men ; and no mother could, with her own industry, possibly suckle and procure nourishment for a numerous family. Here, as in the feathered tribes, the assistance of the father becomes indispensable. On this subject,

subject, a curious instinct merits attention. The male of most birds not only selects a female, but, with great assiduity, brings food to her when sitting on her eggs, and often relieves her by sitting on them himself.

There are other species of pairing birds, whose young, as soon as they are hatched, are capable of eating their food when presented to them, and of course, require less labour from the parents. In these species accordingly, the male pays no attention to the progeny, because it is unnecessary; but the mother carefully leads them about to places where proper food is to be had, protects them from injuries, and communicates heat to them by covering them with her wings.

Quadrupeds, especially those which feed upon grass, do not pair; because while the female gives suck to her young, she herself is feeding. Beside, the young of this tribe, very soon after birth, can eat grass and other vegetables. The Count de Buffon remarks, that the roe-deer, though they feed upon grass, are to be excepted from this rule: for they pair, and have annually but one litter. Lions, tigers, wolves, and other rapacious quadrupeds, do not pair. The whole labour
of

of procuring food is devolved upon the female, which often shortens her own life, as well as that of her offspring. In relation to man, this is a fortunate circumstance; for, if beasts of prey paired, a dangerous multiplication of those destructive species would be the consequence. But pairing is essentially necessary to birds of prey; because, during the process of incubation, the female would not have time sufficient for procuring food; which, in these animals, requires both patience and address. Some quadrupeds, particularly those which lay up provisions for the winter, as the beaver, pair. As soon as the young beavers are produced, the males abandon the stock of provisions to the females, and go in quest of food for themselves. But they by no means relinquish their mates; but frequently return and visit them while they are suckling their young.

If man, and some of the pairing animals be excepted, the seasons of love are limited to particular times of the year. These seasons, though various, are admirably adapted to the nature and œconomy of the different species. In all animals of this kind, the seasons of love, and the times of female gestation,

tation, are so contrived by Nature, that the offspring, when brought forth, are amply supplied with the particular species of food upon which they principally live. Though the times of gestation vary considerably among such quadrupeds as feed upon grass, the respective females uniformly bring forth early in summer, when the grass is tender and luxuriant. The mare comes in season in summer, carries eleven months, and is delivered in the beginning of May. Sheep and goats come in season in the end of October or beginning of November. They carry five months, and produce when the grass begins to spring. It is worthy of observation, that, though the times of gestation in the same species, and in all latitudes, never alter, yet the seasons of love, and times of delivery, vary with the climate.. In Italy, sheep come in season in the months of June or July. The females, as usual, carry five months, and bring forth in November or December, the very period when grass, in that climate, is in its best state for pasture; for, in April, it is burnt up, and sheep have nothing to browse upon but shrubs. The rutting season
of

of the stag is in the end of September and beginning of October, and the female brings forth in May or the beginning of June. These animals inhabit the highest mountains of Scotland, where the grass, of course, does not begin to spring so early as in the lower parts of that country. Beavers come in season about the end of autumn, and bring forth in January, when their store-houses are full of provisions. The young of pairing birds are produced in the spring, when the weather begins to be comfortably warm, and their natural food abounds. In a word, the bringing forth, or hatching, of all animals, not excluding the insect tribes, uniformly takes place at those seasons of the year when the nature of the weather, and the food peculiar to the species, are best adapted to the constitution of their offspring. Catterpillars of every kind are never hatched till the various plants on which they feed, though they grow in different months, have put forth their leaves.

We shall conclude this subject, by giving a Table of the Relative Fecundity, &c. of Animals, which, in a short compass, solves

a number of questions with regard to the natural history of quadrupeds. It is taken from the eighth volume of the Translation of Buffon, to whose authority most readers will be inclined to give great weight.

TABLE

TABLE of the RELATIVE FECUNDITY of ANIMALS.

Names.	Age at which Males can engender, and Females produce.		Times of gestation.		Number of young produced at a litter.		Age at which Males cease to engender, and Females to produce.	
	MALE. Years.	FEMALE. Years.					MALE. Years.	FEMALE. Years.
Elephant	30	30	2 years	1 in three or four years	lives 200			
Rhinoceros	15 or 20	15 or 20	-	-	lives 70 or 80			
Hippopotamus	-	-	9 months	-	-			
Walrus	-	-	1 year nearly idem	-	-			
Camel	4	4	11 months	1, sometimes 2	lives 40 or 50			
Dromedary	4	4	11 months	1, rarely 2	lives 40 or 50			
Horse	2½	2	11 months	1, rarely 2	at 25 or 30			at 18 or 20
Zebra	2	2	11 ditto	1, rarely 2	at 25 or 30			at 18 or 20
Ass	2	2	11 ditto & more	1, rarely 2	at 25 or 30			at 25 or 30
Buffalo	3	3	9 months	1, rarely 2	lives 15 or 18			
Ox	2	1½	9 ditto	1, rarely 2	at 9			at 9
Stag	1½	1½	8 ditto & more	1, rarely 2	lives 30 or 35			
Rain-deer	2	2	8 months	1, rarely 2	lives 16			at 12
Lama	3	3	9 months	1, sometimes 2	-			
Man	14	14	-	1, sometimes 2	-			
Large Apes	3	3	5 ditto	1, sometimes 2	at 8			at 10 or 12
Mouflon	1½	1	5 ditto	twice a year in hot climates	-			
Saiga	1	1	5 ditto	1, sometimes 2	lives 15 or 20			
Roebuck	1½	2	5 ditto	1, 2, sometimes 3	lives 12 or 15			
Chamois	1	1	5 ditto	1, 2, rarely 3	lives 20			
Goat	1	7 months	5 ditto	1, 2, rarely 3, and never above 4	at 7			at 7

Names.	Age at which Males can engender, and Females produce.		Times of gesta- tion.	Number of young produced at a lit- ter.		Age at which Males cease to engender, and Females to produce.	
	MALE. Years.	FEMALE. Years.				MALE. Years.	FEMALE. Years.
Vol. II.							
Sheep	1	1	5 ditto	1, sometimes twice a year in warm climates	2, at 8	-	at 10 or 12
Seal	-	-	several months	2 or 3	-	-	-
Bear	2	2	ditto	1, 2, 3, 4, and ne- ver above 5	lives 20 or 25	-	-
Badger	-	-	-	3 or 4	lives 20 or 25	-	-
Lion	2	2	-	3 or 4 once a year	-	-	-
Leopard & Tiger	2	2	-	4 or 5 once a year	-	-	-
Wolf	2	2	73 days or more	5, 6, to 9, once a year	at 15 or 20	-	at 15 or 20
Dog in a natural state	9 or 10 months	9 or 10 months	63 days	3, 4, 5, 6	at 15	-	at 15
Hiatis	-	-	63 days	6 and 7	-	-	-
Fox	1	1	In season in win- ter, and pro- duces in April.	3, 4, to 6	at 10 or 11	-	at 10 or 11
Jackal	-	-	-	2, 3, or 4	-	-	-
Cat in a natural state	before 1	before 1	56 days	4, 5, or 6	at 9	-	at 9
Martin	1	1	56 days, it is said	3, 4, and 6	at 8 or 10	-	at 8 or 10
Pine Weasel	1	1	idem	3, 4, and 6	at 8 or 10	-	at 8 or 10
Polecat	1	1	idem	3, 4, and 5	generate during life	-	produce during life
Weasel	1st year	1st year	-	3, 4, and 5	idem	-	idem
Ermine	idem	idem	-	idem	idem	-	idem

at 7

at 7

1, 2, rarely 3, and
never above 4

5 ditto

7 months

Names.	Age at which Males can engender, and Females produce.		Times of gestation.		Number of young produced at a litter.		Age at which Males cease to engender, and Females to produce.	
	MALE. Years.	FEMALE. Years.					MALE. Years.	FEMALE. Years.
Squirrel -	1	1		copulates in March, and produces in May	3 or 4			
Flying Squirrel -	1	1			3 or 4			
Hedgehog -	1st year	1st year		40 days	3, 4, and 5			
Dormice -	1st year	1st year			3, 4, and 5			lives 6
Musk Rats -	1st year	1st year			4, 5, and 6			
Opoffums -	1st year	1st year			4, 5, 6, and 7			
Hogs -	1 year or 9 months	1 year or 9 months		4 months	10, 12, 15, to 20, at 15 twice a year		at 15	
Armadillos -	1st year	1st year			4 several times a year			
Hare -	1st year	1st year		30 or 31 days	2, 3, 4, several times a year			lives 7 or 8
Rabbit -	5 or 6 months	5 or 6 months		idem	4, 5, to 8, several times a year			idem
Ferret -	1st year	1st year		40 days	5, 6, to 9, twice a year			during life
Rats -	idem	idem		5 or 6 weeks	5 or 6 several times a year			idem
Field Mice -	idem	idem		1 month, or 5 weeks	9 or 10 several times a year			idem
Moufe -	idem	idem		idem	5 or 6 several times a year			idem

Names.	Age at which Males can engender, and Females produce.		Times of gestation.	Number of young produced at a litter.		Age at which Males cease to engender, and Females to produce.	
	MALE. Years.	FEMALE. Years.				MALE. Years.	FEMALE. Years.
Brown Rat -	idem	idem	-	12 to 19	thrice a year	idem	
Guinea Pig -	5 or 6 weeks	5 or 6 weeks	3 weeks	eight times a year	lives 6 or 7, and produces during life		
				1st litter, 4 or 5 ;			
				2d, 5 or 6 ; and			
				the others, 7, 8,			
				to 11			

CHAPTER XII.

Of the Transformation of Animals.

THE transformation of caterpillars, and of different kinds of worms, into winged insects, has long excited the attention, as well as the admiration of mankind. But the truth is, that every animal, without exception, undergoes changes in their structure, mode of existence, and external appearance. Mankind, from their embryo state, to final dissolution, assume many different forms. Some weeks after conception, the rudiments of a human being are to be perceived. As pregnancy advances, the approaches to the perfect figure become gradually more distinguishable, till the period of birth. While in the foetus state, the head is disproportionally large, when compared with the other parts of the body; nourishment is conveyed to it by very different channels; and respiration is not necessary, because the circulation

tion of the blood is not carried on in the same manner as after birth. Even after birth, the form, symmetry, and organs of the animal are by no means complete. The head continues for some time to be disproportionally large; the hands and feet are not properly shaped: the legs are crooked; the hair on the head is short and scanty; no teeth as yet appear; and there is not a vestige of a beard. In a few months, however, the symmetry of all the parts is evidently improved and the teeth begin to shoot. The growth of the whole body, as well as the strength and beauty of its form, gradually advance to perfection till the sixth or seventh year, when another change takes place. At this period, the first set of teeth are shed, and are replaced by new ones. From boyhood to puberty, the size of the body, and of its different members, increase. When the age of puberty arrives, several important changes are produced in the system of both males and females. The beard now makes its appearance; the dimensions of the body, in most individuals, are suddenly augmented; and both sexes become capable of multiplying the species. From this period, to the age of twenty-five

ty-five or thirty, the muscles swell, their interstices are filled with fat, the parts bear a proper proportion to each other, and man may now be considered as perfect animal. In this state of bodily perfection and vigour, he generally remains till he reaches his fiftieth year. Then a new but a gradual change begins to appear. From the fiftieth year to the age of seventy or eighty, the powers of the body decline in their strength and activity. The muscles lose their spring and their force. The vigour of manhood is no longer felt; and the withered decrepitude of old age is succeeded by death, its unavoidable consequence.

The mind of man undergoes changes as well as his body. The taste, the appetites, and the dispositions, are in perpetual fluctuation. How different is the taste of a child from that of a man? Fond of gewgaws and of trifling amusements, children frolic away their time without much thought or reflection. When advancing toward puberty, their dispositions and desires suffer a gradual mutation. New instincts are unfolded, and a sense of propriety begins to be perceived. They despise their former occupations and amusements; and different species of objects solicit

solicit and obtain their attention. Their powers of reflection are now considerably augmented; and both sexes acquire a modesty and a shyness with regard to each other. This awkward, but natural bashfulness, by the intercourse of society, as well as by the impulses of Nature, vanishes soon after puberty, when the state of manhood and of gallantry commences. From this period, to the age of twenty-five or thirty, men's minds assume a bold, enterprising, and active tone. They engage in the business of life, look forward to futurity, and have a desire of marrying, and of establishing families. All the social appetites are in vigour; solid and manly friendships are formed; and man goes on for some time to enjoy every kind of happiness which his nature is capable of affording. I wish the next change had no existence. At fifty or sixty, the mental powers, in general, like those of the body, begin to decline, till feeble and tremulous old age arrives, and death closes the mutable scene of human life.

With regard to *quadrupeds*, both before and after birth, they undergo similar, and many of them greater, changes of form than those
of

of the human species. Their mental powers, likewise, their dispositions and manners, as well as the object of their attention, vary according to the different stages of their existence. Many of them come into the world blind, and continue for some time before they receive the sense of seeing. How many changes are exhibited in the dog from birth till he becomes a perfect animal, till all his members are completely formed, and all his instincts are unfolded and improved by experience and education? The deer-kind acquire not their magnificent and beautiful horns before the age of puberty; and even these are annually cast off and renewed. Similar changes take place in quadrupeds of every denomination; with examples of which every man's experience and recollection will readily supply him; and, therefore, it is unnecessary to be more particular.

Neither are *Birds*, in their progress from birth to maturity, exempted from changes. Like quadrupeds, many birds are blind for some time after they are hatched. In this condition, how different are their form and appearances from those of the perfect animals! At first, they are covered with a kind of down
instead

instead of feathers. Even after the feathers shoot, they are often of a colour different from that which they acquire when full grown. The beautifully variegated colours of the peacock's tail appear not till he arrives at his third year*. Birds that have crests, or wattles, live a considerable time before they acquire these ornaments, or marks of distinction. All birds annually molt, or cast their feathers, in the same manner as quadrupeds shed their hair, the new pushing out the old.

Frogs, and many other *amphibious* animals, undergo great changes in their form and structure. When it first escapes from the egg, a frog appears in the form of a tadpole, an animal with a large roundish head, and a compressed or flat tail, but totally destitute of feet and legs. In this state it remains a considerable time, when the two fore-feet begin to shoot, and have an exact resemblance to the buds of trees. As their growth advances, the toes and legs are distinguishable. The same process goes on with the hind-legs, only they are somewhat later in making their appearance. During the growth of the legs,

* Linnaei Amoen. Acad. vol. 4. p. 368.

the blood being drawn into different channels, the tail suffers a gradual mortification, till at last it totally vanishes, and the tadpole is metamorphosed into a quadruped. Tadpoles never comes out of the water; but, after their transformation into frogs, they become amphibious, and occasionally frequent both land and water.

The *crustaceous* tribes, as lobsters, crabs, &c. beside the different appearances they assume while growing to perfection, cast their shells every year. When this change is about to happen, they retire into the crevices of rocks, or shelter themselves below detached stones, with a view to conceal and defend their bodies from the rapacious attacks of other fishes. After the shells are cast, the animals are exceedingly weak and defenceless. Instead of their natural defence of hard shells, and strong claws, they are covered only with a thin membrane or skin. In this state they become an easy prey to almost every fish that swims. The skin, however, gradually thickens and grows harder, till it acquires the usual degree of firmness. By this time the animals have resumed their former strength and activity; they come out from
their

their retirements, and go about in quest of food.

Serpents, and many other *reptiles*, cast their skins annually. The beauty and lustre of their colours are then highly augmented. Before casting, the old skins have a tarnished and withered appearance. The old skins, like the first set of teeth in children, are forced off by the growth of the new.

We come now to give some account of the transformations of *insects*, which are both various and wonderful. All winged insects, without exception, and many of those which are destitute of wings, must pass through several changes before the animals arrive at the perfection of their natures. The appearance, the structure, and the organs of a caterpillar, of a chrysalis, and of a fly, are so different, that, to a person unacquainted with their transformations, an identical animal would be considered as three distinct species. Without the aid of experience, who could believe that a butterfly, adorned with four beautiful wings, furnished with a long spiral proboscis or tongue, instead of a mouth, and with six legs, should have proceeded from a disgusting, hairy caterpillar, provided
with

with jaws and teeth, and fourteen feet? Without experience, who could imagine that a long, white, smooth, soft worm, hid under the earth, should be transformed into a black, crustaceous beetle, having wings covered with horny clytra, or cases?

Upon this branch of the subject, we shall, *first*, give an example or two of the most common transformations of Insects: and *secondly*, describe some of the more uncommon kinds.

Beside their final metamorphosis into flies, caterpillars undergo several immediate changes. All caterpillars cast or change their skins oftner or more seldom, according to the species. Malpighius informs us, that the silk-worm, previous to its chrysalis state, casts its skin four times. The first skin is cast on the 10th, 11th, or 12th day according to the nature of the season; the second in five or six days after; the third in five or six days more; and the fourth and last in six or seven days after the third. This changing of skin is not only common to all caterpillars, but to every insect whatever. Not one of them arrives at perfection without casting its skin at least once or twice. The skin,
after

after it is cast, preserves so entirely the figure of the caterpillar in its head, teeth, legs, colour, hair, &c. that it is often mistaken for the animal itself. A day or two before this change happens, caterpillars take no food: They lose their former activity, attach themselves to a particular place, and bend their bodies in various directions, till at last they escape from the old skin, and leave it behind them. The intestinal canal of caterpillars is composed of two principal tubes, the one inserted into the other. The external tube is compact and fleshy; but the internal one is thin and transparent. Some days before caterpillars change into the chrysalis state, they void, along with their excrement, the inner tube which lined their stomach and intestines. When about to pass into the chrysalis state, which is a state of imbecillity, caterpillars select the most proper places and modes of concealing themselves from their enemies. Some, as the silk-worm, and many others, spin filken webs or cods round their bodies, which completely disguise the animal form. Others leave the plants upon which they formerly fed, and hide themselves in little cells which they make in the earth.

The

The rat-tailed worm abandons the water upon the approach of its metamorphosis, retires under the earth, where it is changed into a chrysalis, and, after a certain time, bursts from its seemingly inanimate condition, and appears in the form of a winged insect. Thus the same animals pass the first and longest period of their existence in the water, another under the earth, and the third and last in the air. Some caterpillars, when about to change into a chrysalis state, cover their bodies with a mixture of earth and of silk, and conceal themselves in the loose soil. Others incrust themselves with a silky or glutinous matter, which they push out from their mouths, without spinning it into threads. Others retire into the holes of walls or of decayed trees. Others suspend themselves to the twigs of trees, or to other elevated bodies, with their heads undermost. Some attach themselves to walls, with their heads higher than their bodies, but in various inclinations; and others choose a horizontal position. Some fix themselves by a gluten, and spin a rope round their middle to prevent them from falling. Those which feed upon trees attach

tach themselves to the branches, instead of the leaves, which are less durable, and subject to a greater variety of accidents. The colours of the caterpillars give no idea of those of the future flies.

In general, the figure of chrysalids approaches to that of a cone, especially in their posterior part. When under this form, the insect seems to have neither legs nor wings. It is incapable either of walking or of crawling. It takes no nourishment, because it has no organs suited to that purpose; yet, in some species, life is continued for several months before their last metamorphosis takes place. In a word it seems to be a lifeless mass. But, upon a more attentive observation, it possesses the power of bending upwards and downwards the posterior part of its body. The skin, or exterior covering, of those which do not spin cods, seems to be of a cartilaginous nature. It is commonly smooth and shining. In some species, however, the skin of the chrysalis is more or less covered with hair, and other rugosities. Though chrysalis differ both in figure and colour, their appearances are by no means so various as those of the caterpillars from which

which they are produced. The colour of some chrysalids is that of pure gold, from which circumstance the whole have received their denomination. For the same reason they are called *aureliae* in Latin. Some are brown, others green; and, indeed, they are to be found of almost every colour and shade.

The life of winged insects consists of three principal periods, which present very different scenes to the student of Nature. In the first period, the insect appears under the form of a *worm* or *caterpillar*. Its body is long, cylindrical, and consists of a succession of rings, which are generally membranous, and encased within each other. By the aid of its rings, or of crotchets, or several pairs of legs, it crawls about in quest of food; and its movements are, in some species, remarkably quick. Its head is armed with teeth, or pincers, by which it eats the leaves of plants or other kinds of food. In this state, it is absolutely deprived of sex, and, consequently, of the power of multiplication. Its blood moves from the tail toward the head. It respire either by stigmata or small apertures placed on each side of its body,
or

or by one or several tubes situated on its posterior part, which have the resemblance of so many tails. In the second period, the insect appears under the form of a nymph, or that of a chrysalis. When an insect, after throwing off the skin of the caterpillar, exhibits all its external parts, only covered with soft and transparent membranes, it is called a *nymph*. But, when to these membranes is added a common and crustaceous covering, it receives the name of a *chrysalis*. While in the state of a nymph, or that of a chrysalis, insects, in general, are totally inactive, and seem not to possess any powers of life. Sunk into a kind of deep sleep, they are little affected with external objects. They can make no use of their eyes, their mouth, or any of their members; for they are all imprisoned by coverings more or less strong. No cares occupy their attention. Deprived of the faculty of motion, they remain fixed in those situations which they have chosen for their temporary abode, or where chance has placed them, till their final metamorphosis into flies. Some of them, however, are capable of changing place; but their movements are slow and

painful. Their blood circulates, but in a contrary direction from what takes place in the caterpillar state; for it proceeds from the head toward the tail. Respiration continues to go on, but the organs are differently situated. In the caterpillar, the principal organs of respiration were placed at the posterior part of the body; but now these same organs are to be found at the anterior part of the animal. In the third period, the insect has acquired that perfect organization which corresponds to the rank it is to hold in the scale of animation. The bonds of the nymph, or of the chrysalis, are now burst asunder, and the insect commences a new mode of existence. All its members, formerly soft, inactive, and folded up in an envelope, are expanded, strengthened, and exposed to observation. Under the form of a worm or caterpillar, it crawled; under those of a nymph, or chrysalis, its power of motion was almost annihilated; under the last form, it is furnished with six springy legs, and two or four wings with which it is enabled to fly through the air. Instead of teeth or pincers, with which it divided a gross aliment, it has now a trunk by which it extracts the refined

refined juices of the most delicate flowers. Instead of a few smooth eyes which it possessed in the worm or caterpillar state, the new insect is furnished with both smooth and convex eyes, to the number of several thousands.

The internal parts of the insect have likewise undergone as many changes as the external. The texture, the proportions, and the number of the viscera, are greatly altered. Some have acquired an additional degree of consistence; others, on the contrary, are rendered finer and more delicate. Some receive a new form, and others are entirely annihilated. Lastly, some organs in the perfect insect, which seemed formerly to have no existence, are unfolded, and become visible. The most important of this last kind are the organs of generation. The caterpillar, the nymph, and the chrysalis, were of no sex. But, after transformation, both sexes are distinguishable, and the animals are capable of multiplying their species.

We shall now give some examples of transformations which deviate from the common mode.

Some insects hold a middle rank between those which preserve their original figure

during life, and those that suffer transformations. Their existence is divided into two periods only. They walk in the first, and fly in the second. Thus their only metamorphosis consists of the addition of wings, the growth and expansion of which are performed without any considerable alteration in the figure of their bodies.

There is not a law established among organized bodies which seems to be so universal, as that all of them grow, or augment in size, after birth, till they arrive at maturity. If a hen were to bring forth an egg as large as her own body, and if this egg, when hatched, were to produce a bird of equal dimensions with either of the parents, it would be considered as a miracle. But the *spider-fly*, so denominated from its figure, affords an example of a similar prodigy. This fly actually lays an egg, from which a new fly is hatched that is as large and as perfect as its mother. This egg is roundish, is at first white, and afterwards assumes a shining black colour. Upon a more accurate examination, however, this production was found to be an egg only in appearance. When the envelope is removed, instead of
a gelatinous

a gelatinous substance, the new insect, furnished with all its members, is discovered. But this discovery does not render the fact the less wonderful. All winged insects undergo their different transformations after being expelled from the bodies of their mothers, and receive great augmentations of size before their metamorphosis into the nymph or chrysalis state, after which their growth stops. But the spider-fly affords an instance of an insect transformed in the belly of its mother, and which grows no more after it escapes from its envelope. This fact is fully authenticated by Reaumur*, Bonnet†, and other naturalists.

The worm from which the tipula or crane-fly is produced is perfectly smooth. Immediately before its first transformation it retires under ground. After this metamorphosis, the surface of the nymph is furnished with a number of prickles. By means of these prickles, the nymph, when about to be transformed into a fly, raises itself in its hole till the chest of the insect is above ground. The fly then

* Reaumur, vol. 12. p. 412. edit. 12mo.

† Oeuvres de Bonnet, vol. 4. p. 28. edit. 8vo.

bursts its prison, mounts into the air, and leaves its former covering behind in the earth.

Many species of flies deposit their eggs in the leaves and different parts of plants. Soon after the egg is inserted into the leaf, a small tubercle begins to appear, which gradually increases in magnitude till the animal is hatched, and has passed through its different transformations. These tubercles are known by the name of *galls*, and are very different in their form, texture, colour, and size. Galls of every kind, however, derive their origin from the stings of insects, which generally belong to the class of flies. The female fly, by means of her sting, makes incisions in the leaves or branches of a tree, and in each incision she lays an egg. This egg is at first extremely minute; but it soon acquires a considerable bulk, and the gall has arrived at its full size before the worm is hatched. This gall seems to be analogous to the membranes which invest a foetus, and expand in all directions in proportion to its growth. That the eggs of oviparous animals grow while in the ovarium is universally known; but it is singular that the eggs of gall-flies should grow

grow after being separated from the body of the mother. These eggs must undoubtedly be furnished with external vessels, or a kind of roots, by which they extract juices from the internal cavity of the gall. Malpighius ascribes the origin of galls to a corrosive liquor introduced by the fly into the wound. But Reaumur, to account for the growth of a gall, thinks it unnecessary to have recourse to any supposed poisonous fluids, and attributes it to the superabundant nutritious juices derived to that particular part by the continual action of the absorbent vessels of the egg, joined to its heat, which may be compared to a little fire placed in the centre of the tumour.

Whether these causes are sufficient to explain the growth of galls, we shall submit to the judgment of the reader. But, that the eggs deposited by the flies augment in size; that worms proceed from them; that these worms are nourished, and live a certain time imprisoned in the galls; that they are there transformed into nymphs or chrysalids; and, lastly, that they are metamorphosed into winged insects, which, by gnawing an aperture through the gall, take their flight in the air; are

are known and incontestible facts, of the truth of which every man may easily satisfy himself. Examine the common oak-galls, or those of any other tree; if any of them happen to have no aperture, cut them gently open, and you are certain to find an egg, a worm, a chrysalis, or a fly: But in such as are perforated by a cylindrical hole, not a vestige of an animal is discoverable. The galls which make an ingredient in the composition of ink are thick, and their texture is very strong and compact. That the small animals they contain should be able to pierce through such a rigid substance is truly wonderful.

In the general order of Nature among oviparous animals, each egg includes one embryo only. A singular species of eggs, however, discovered by the celebrated Mr. Folks, late President of the Royal Society of London, must be excepted. He found great numbers of them in the mud of small rivulets. In size they equalled the head of an ordinary pin. They were of a brown colour, and their surface was crustaceous, through which, by employing the microscope, several living worms were distinctly perceptible. By dexterously breaking the shell, he dislodged them; and he
found

found with surprize, that eight or nine worms were contained in, and proceeded from, the same egg. They were all well formed, and moved about with great agility. Each of them was inclosed in an individual membranous covering, which was extremely thin and transparent. It were to be wished that the transformations of these extraordinary animals had been traced.

Some caterpillars, when about to transform, make a belt pass round their bodies. This belt is composed of an assemblage of filken threads spun by themselves, the ends of which they paste to the twigs of bushes, or other places where they choose to attach their bodies. They likewise fix their hind-legs in a tuft of silk. After transformation, the chrysalids remain fixed in the same manner as before their metamorphosis. The belt is loose, and allows the chrysalis to perform its slow and feeble movements.

The whole moth-kind, as well as the silk-worm, immediately before their transformation into the chrysalis state, cover their bodies with a cod or clue of silk, though the nature of the silk, and their mode of spinning, are very different. The cods of the silk-worm are composed

posed of pure filk. Their figure is generally oval, which necessarily results from that of the animal's body upon which they are moulded. When spinning, they twist their bodies into the form of an S. The cod is produced by numberless circumvolutions and zigzags of the same thread. The filk is spun by an instrument situated near the mouth of the insect. The silky matter, before it is manufactured by the spinning instrument, appears under the form of a gum almost liquid, which is contained in two large reservoirs contorted like the intestines of larger animals, and which terminate at the spinning instrument, by two parallel and slender conduits. Each conduit furnishes matter for one thread. The spinning instrument, as is evident when viewed by the microscope, unites the two threads into one. Thus a thread of filk, which has the appearance of being single, is in reality double, and spun with great dexterity. Some writers, who delight in the marvellous, ascribe foresight to the filk-worm in spinning its cod. The filk-worm, it must be acknowledged, acts as if it foresaw the approaching event. But the truth is, that, when the animal has acquired its full growth, its reservoirs of filk are completely filled.

filled. It then seems to be strongly stimulated to evacuate this glutinous matter. Its different movements and attitudes, while discharging the silk, produce those oval bundles which clothe and ornament vast numbers of the human species.

Another species of caterpillar constructs its cod in the form of a boat with the keel uppermost; but it consists not entirely of pure silk. The animal, with its teeth, detaches small triangular pieces of bark from a bush or a tree. These pieces of bark it pastes upon its body, by means of a glutinous or silky substance, and they constitute a principal part of its cod.

Another species works also in wood, though not with equal art as the former. Its cod is composed entirely of small irregular fragments of dried wood. These fragments the animal has the address to unite together, and to form of them a kind of box which covers and defends its whole body. It accomplishes this purpose by moistening, for some moments, the pieces of wood in its mouth, and then attaches them to each other by a glutinous substance. Of this mixture the caterpillar forms a cod, the solidity of which is nearly equal to that of wood.

The

The most solitary of all insects are those who live in the internal parts of fruits. Many of them undergo their metamorphosis in the fruit itself, which affords them both nourishment and a safe retreat. They dig cavities in the fruit, which some of them either line with silk, or spin cuds. Others leave the fruit, and retire to be transformed in the earth.

The metamorphosis of insects has been regarded as a sudden operation, because they often burst their shell or silky covering quickly, and immediately appear furnished with wings. But by more attentive observation, it has been discovered that the transformation of caterpillars is a gradual process from the moment the animals are hatched till they arrive at a state of perfection. Why, it may be asked, do caterpillars so frequently cast their skins? The new skin, and other organs, were lodged under the old ones, as in so many tubes or cases, and the animal retires from these cases, because they have become too strait. The reality of these encasements has been demonstrated by a simple experiment. When about to molt or cast its skin, if the foremost legs of a caterpillar are cut off, the animal comes out of the old skin deprived of these legs. From this fact,
Reaumur

Reaumur conjectured, that the chrysalis might be thus encased, and concealed under the last skin of the caterpillar. He discovered that the chrysalis, or rather the butterfly itself, was inclosed in the body of the caterpillar. The proboscis, the antennae, the limbs, and the wings, of the fly are so nicely folded up, that they occupy a small space only under the two first rings of the caterpillar. In the first six limbs of the caterpillar are encased the six limbs of the butterfly. Even the eggs of the butterfly have been discovered in the caterpillar long before its transformation.

From these facts it appears, that the transformation of insects is only the throwing off external and temporary coverings, and not an alteration of the original form. Caterpillars may be considered as analogous to the foetuses of men and of quadrupeds. They live and receive nourishment in envelopes till they acquire such a degree of perfection as enables them to support the situation to which they are ultimately destined by Nature.

One would not readily believe that the *excrements* of a butterfly should be capable of exciting consternation in the minds of the people. But this event has frequently happened

pened in different places and nations. Among many other prodigies which have terrified nations, *showers of blood* have been enumerated by historians. These showers of blood were supposed to portend great and calamitous events, as wars, the destruction of cities, and the overthrow of empires. About the beginning of July, in the year 1608, one of these pretended showers of blood fell in the suburbs of Aix, and for several miles round. This supposed shower of blood, M. de Reaumur remarks, would probably have been transmitted to us as a great and a real prodigy, if Aix had not then been possessed of a philosopher, who, amidst other species of knowledge, did not neglect the operations and oeconomy of insects. This philosopher was M. de Peiresc, whose life is written by Gassendi. This life contains a number of curious facts and observations. Among others, M. de Peiresc discovered the cause of the pretended shower of blood at Aix, which had created so general an alarm. About the beginning of July, the walls of a church-yard adjacent to the city, and particularly the walls of the small villages in the neighbourhood, were observed to be spotted with large drops of a blood-coloured liquid.

quid. The people, as well as some theologians, considered those drops as the operation of forcerers, or of the Devil himself. M. de Peiresc, about that time, had picked up a large and beautiful chrysalis, which he laid in a box. Immediately after its transformation into the butterfly state, M. de Peiresc remarked, that it had left a drop of blood-coloured liquor on the bottom of the box, and that this drop, or stain, was as large as a French sou. The red stains on the walls, on stones near the highways, and in the fields, were found to be perfectly similar to that on the bottom of M. de Peiresc's box. He now no longer hesitated to pronounce, that all those blood-coloured stains, wherever they appeared, proceeded from the same cause. The prodigious number of butterflies which he, at the same time, saw flying in the air, confirmed his original idea. He likewise observed, that the drops of the miraculous rain were never found in the middle of the city; that they appeared only in places bordering upon the country; and that they never fell upon the tops of houses, or upon walls more elevated than the height to which butterflies generally rise. What M. de Peiresc saw himself, he showed to many persons

persons of knowledge, or of curiosity, and established it as an incontestible fact, that the pretended drops of blood were, in reality, drops of a red liquor deposited by butterflies.

To the same cause M. de Peiresc attributes some other showers of blood related by historians; and it is worthy of remark, that all of them are said to have happened in the warm seasons of the year, when butterflies are most numerous. Among others, Gregory of Tours mentions a shower of blood which fell, in the time of Childebert, in different parts of Paris, and upon a certain house in the territory of Senlis; and, about the end of the month of June, another likewise fell under the reign of King Robert.

M. de Reaumur remarks, that almost all the butterflies which proceeded from different species of hairy caterpillars in his possession, voided at least one, and often several large drops of excrement, which had the colour of blood. The hairy caterpillar that feeds upon the leaves of the elm-tree, after its transformation, emits drops, the colour of which is of a more deep red than that of blood; and, after being dried, their colour approaches to that of carmine. From another caterpillar of the elm,
which

which is larger, and much more common than the former, proceeds a butterfly, that, immediately after its transformation, emits a great quantity of red excrement. This species of caterpillar, in particular years, is so numerous, that it lays bare the whole trees in certain districts. Myriads of them are transformed into chrysalids about the end of May or beginning of June. When about to undergo their metamorphosis, they often attach themselves to the walls, and even enter into the country houses. If these butterflies were all brought forth at the same time, and flew in the same direction, their number would be sufficient to form small clouds to cover the stones, &c. of particular districts with blood-coloured spots, and to convince those who wish to fright themselves, and to see prodigies, that a shower of blood had fallen during the night. Some of those hairy caterpillars which live in society upon nettles, likewise emit an excrementitious matter of a red colour. A thousand examples of the same kind might be enumerated. Hence the notion of miraculous or portentous showers of blood should be for ever banished from the minds of men.

I would not have said so much upon this subject, if I had not considered it to be the duty of every man, when it is in his power, to remove popular prejudices, especially when they have a direct tendency to terrify the minds of men, and to cherish ignorance and superstition.

We not only read of showers, but, what seems to be more unaccountable, of fountains running occasionally with blood instead of water. Sir David Dalrymple, one of the Senators of the College of Justice in Scotland, a gentleman not more distinguished by his learning and deep research, than by his scrupulous integrity and propriety of conduct, relates, in his *Annals of Scotland* *, upon the authority of Hoveden and Benedictus Abbas, that, in the year 1184, ‘ A fountain near Kil-
 ‘ winning †, in the shire of Air, ran blood
 ‘ for eight days and eight nights without in-
 ‘ termiſſion. This portent had frequently
 ‘ appeared, but never for so long a space. In
 ‘ the opinion of the people of the country it
 ‘ prognosticated the effusion of blood. Bene-

* Vol. I. page 298.

† A Scottish village.

dictus Abbas, and R. Hoveden, relate the story of this portent with perfect credulity. Benedictus Abbas improves a little upon his brother; for he is positive that the fountain flowed with *pure* blood.' If Kilwinning, like Aix, had possessed such a philosopher as Peiresc, the redness of the water, if ever it did appear, would have received a most satisfactory explanation.

Transformations are not peculiar to animals, All *organized bodies* pass through successive changes. Plants, of course, are not exempted from mutation. What an amazing difference between an acorn and a stately oak? The seeds of plants may be compared to the chrysalids of butterflies. The seed, like the chrysalis, contains, in miniature, all the parts of the future plant. These parts require only time, and other circumstances necessary to vegetation, for their complete evolution. How different are the seed-leaves from those of the plume? Beside the general changes arising from growth, plants undergo a number of metamorphosis from other causes. In northern climates, if we except a few ever-greens, trees, during winter, are entirely stripped of their leaves. Instead of the pleasant emoti-

ons excited by the variety of figures, movements, colours, and fragrance of the leaves, flowers, and fruit, during the spring and summer, nothing is exhibited in winter but the bare stems and branches. In this state, the trees of the forest have a lugubrious appearance, and remind us of death and of skeletons. Very different are the emotions we feel in the spring, when the buds begin to burst, and the leaves to expand. When summer approaches, another beautiful change takes place. The flowers, with all their splendour of colours, and sweetness of flavours, are then highly delightful to our senses. After performing the office of cherishing and protecting the tender fruit for some time, the flowers drop off, and a new change is exhibited. When the flowers fall, the young fruit appear, and gradually grow to maturity, perpetually presenting varieties in their magnitude, colour, odour, and flavour. When the fruit or seeds are fully ripe, they are gathered for the use of man, drop down upon the earth, or are devoured by birds and other animals. After this change happens, to which all the others were only preparatory, the leaves begin to shed, winter commences,
and

and the same series of metamorphosis go on during the existence of the plant.

The changes just now mentioned are annual, and are ultimately intended to supply men and other animals with food. But plants are subjected to changes of form from causes of a more accidental nature. Varieties or changes in the figure of plants are often produced by soil, by situation, by culture, and by climate.

A plant is composed of the bark, the liber or inner circle, the wood, and the pith. The calyx or cup, the corolla or flower leaves, the stamina, and pistils, are only expansions of the bark, the liber, the wood, and the pith. The petals of all flowers, in a natural state, are single. But, when transplanted into gardens, many of them, especially those which are furnished with numerous stamina, as the anemone, the poppy, the peony, the ranunculus, the daisy, the marigold, the rose, &c. double, or rather multiply their flower-leaves without end. This change from single to double, or monstrous flowers, as they are called, is produced by too great a quantity of nutritious juices, which prevents the substance of the liber from condensing into wood;
and

and transforms the stamina into petals; and it not unfrequently happens, that, when these double flowering plants are committed to a poor soil, they become drier, are reduced to their natural state, and produce single flowers only. Plants which inhabit the valleys, when transported to the tops of mountains, or other elevated situations, not only become dwarfish, but undergo such changes in their general structure and appearance, that they are often thought to belong to a different species, though they are, in reality, only varieties of the same. Similar changes are produced when Alpine or mountain plants are cultivated in the valleys.

From culture and climate, likewise, plants undergo many changes. But this subject is so generally known, that to enlarge upon it would be entirely superfluous. We shall only remark, that the older botanists, when they perceived the same species of plants growing in a different soil, or in a different climate, assume such different appearances, considered and enumerated them as distinct species. But the modern botanists, to prevent the unnecessary multiplication of separate beings, have endeavoured to reduce all those

varieties

varieties arising from fortuitous circumstances to their original species.

From these facts, and many others which might be mentioned, it appears, that, in both the animal and vegetable kingdoms, forms are perpetually changing. The mineral kingdom is not less subject to metamorphoses; but these belong not to our present subject. Though forms continually change, the quantity of matter is invariable. The same substances pass successively into the three kingdoms, and constitute, in their turn, a mineral, a plant, an insect, a reptile, a fish, a bird, a quadruped, a man. In these transformations, organized bodies are the principal agents. They change or decompose every substance that either enters into them, or is exposed to the action of their powers. Some they assimilate, by the process of nutrition, into their own substance; others they evacuate in different forms; and these evacuations make ingredients in the compositions of other bodies, as those of insects, whose multiplication is prodigious, and affords a very great quantity of organized matter for the nourishment and support of almost every animated being. Thus, from the

the apparently vilest and most contemptible species of matter, the richest productions derive their origin. The most beautiful flowers, the most exquisite fruits, and the most useful grain, all proceed from the bosom of corruption. The earth is continually bestowing fresh gifts upon us; and her powers would soon be exhausted, if what she perpetually gives were not perpetually restored to her. It is a law of Nature, that all organized bodies should be decomposed, and gradually transformed into earth. While undergoing this species of dissolution, their more volatile particles pass into the air, and are diffused through the atmosphere. Thus animals, at least portions of them, are buried in the air, as well as in the earth, or in water. These floating particles soon enter into the composition of new organized beings, who are themselves destined to undergo the same revolutions. This circulation of organized matter has continued since the commencement of the world, and will proceed in the same course till its final destruction.

With regard to the intentions of Nature in changing forms, a complete investigation of them exceeds the powers of human research.

search. One great intention, from the examples above enumerated, cannot escape observation. In the animal world, every successive change is a new approach to the perfection of the individuals. Men, and the larger animals, some time after the age of puberty, remain stationary, and continue to multiply their species for periods proportioned to their respective species. When those periods terminate, they gradually decay till their final dissolution. The same observation is applicable to the insect tribes, whose transformations strike us with wonder. The caterpillar repeatedly moults or casts off its skin. The butterfly existed originally in the body of the caterpillar; but the organs of the fly were too soft, and not sufficiently unfolded. It remains unfit to encounter the open air, or to perform the functions of a perfect animal, till some time after its transformation into a chrysalis. It then bursts through its envelope, arrives at a state of perfection, multiplies its species, and dies. All the changes in the vegetable kingdom tend to the same point. In the process of growing, they are perpetually changing forms till they produce fruit, and then they decay. Some plants, like caterpillars,

lars, go through all their transformations, death not excepted, in one year. But others, like man and the larger animals, beside the common changes produced by growth and the evolution of different organs, continue for many years in a state of perfection before the periods of decay and of dissolution arrive. But these perennial plants undergo, every year, all the vicissitudes of the annuals. They every year increase in magnitude, send forth new leaves and branches, ripen and disseminate their seeds, and, during winter, remain in a torpid state, or suffer a temporary death. These annual changes in trees, &c. have some resemblance to those of animals, which produce at certain stated seasons only.

The distribution of life to an immensity of successive individuals seems to be another intention of Nature in changing forms, and in the dissolution of her productions. Were the existence of individuals perpetual, or were it prolonged for ten times the periods now established, life would be denied to myriads of animated beings, who enjoy their present limited portion of happiness.

CHAPTER XIII.

Of the Habitations of Animals.

MANY animals, as well as those of the human species, are endowed by Nature with an architectonic faculty. This faculty is bestowed upon them for a number of wise and useful purposes. It enables them to construct proper habitations for concealing themselves, for defending them against the attacks of their enemies, for sheltering and cherishing their young, and from protecting them from the injuries of the weather.

All animals of the same species, when not restrained by accidental causes, uniformly build in the same style, and use the same materials. From this general rule man is to be excepted. Possessed of a superior number of instincts, of which the reasoning faculty is a result *, he can build in any style,

* See Chap. V. Of Instinct.

and

and employ such materials as his taste, his fancy, or the purposes for which the fabric is intended, shall direct him. A cottage or a palace are equally within the reach of his powers. In treating of this subject we mean not to trace the progress of human architecture, which, in the earlier stages of society, is extremely rude, but to confine ourselves to that of the inferior tribes of animated beings.

With regard to *Quadrupeds*, many of them employ no kind of architecture, but live continually, and bring forth their young, in the open air. When not under the immediate protection of man, these species, in rough or stormy weather, shelter themselves among trees or bushes, retire under the coverture of projecting rocks, or the sides of hills opposite to those from which the wind proceeds. Beside these arts of defence, to which the creatures are prompted by instinct and experience, Nature furnishes them, during the winter months, with a double portion of long hair, which protects them from cold and other assaults of the weather.

Of the quadrupeds that make or choose habitations for themselves, some dig holes
in

in the earth, some take refuge in the cavities of decayed trees, and in the clefts of rocks, and some actually construct cabins or houses. But the artifices they employ, the materials they use, and the situations they select, are so various, and so numerous, that our plan necessarily limits us to a few of the more curious examples.

The Alpine marmot is a quadruped about sixteen inches in length, and has a short tail. In figure, the marmots have some resemblance both to the rat and to the bear. When tamed, they eat every thing presented to them, as flesh, bread, fruit, roots, pot-herbs, insects, &c. They delight in the regions of frost and snow, and are only to be found on the tops of the highest mountains. These animals remain in a torpid state during winter. About the end of September or the beginning of October they retire into their holes, and never come abroad again till the beginning of April. Their retreats are formed with much art and precaution. With their feet and claws, which are admirably adapted to the purpose, they dig the earth with amazing quickness, and throw it behind them. They do not make a simple hole, or a
straight

straight or winding tube, but a kind of gallery in the form of a Y, each branch of which has an aperture, and both terminate in a capacious apartment, where several of the animals lodge together. As the whole operation is performed on the declivity of a mountain, this innermost apartment is alone horizontal. Both branches of the Y are inclined. One of the branches descends under the apartment, and follows the declivity of the mountain. This branch is a kind of aqueduct, and receives and carries off the excrements of the animals; and the other, which rises above the principal apartment, is used for coming in and going out. The place of their abode is well lined with moss and hay, of which they lay up great store during the summer. They are social animals. Several of them live together, and work in common when forming their habitations. Thither they retire during rain, or upon the approach of danger. One of them stands centinel upon a rock, while the others gambol upon the grass, or are employed in cutting it, in order to make hay. If the centinel perceives a man, an eagle, a dog, or other dangerous animal, he alarms his companions

panions by a loud whistle, and is himself the last that enters the hole. As they continue torpid during winter, and, as if they foresaw that they would then have no occasion for victuals, they lay up no provisions in their apartments. But, when they feel the first approaches of the sleeping season, they shut up both passages to their habitation; and this operation they perform with such labour and solidity, that it is more easy to dig the earth any where else than in such parts as they have thus fortified. At this time they are very fat, weighing sometimes twenty pounds. They continue to be plump for three months; but afterwards they gradually decline, and, at the end of winter, they are extremely emaciated. When seized in their retreats, they appear rolled up in the form of a ball, and covered with hay. In this state they are so torpid that they may be killed without seeming to feel pain. The hunters select the fattest for eating, and keep the young ones for taming. Like the dormice, and all the other animals which sleep during winter, the marmots are revived by a gradual and gentle heat: And it is remarkable that those which are fed in houses, and

kept warm, never become torpid, but are equally active and lively during the whole year.

We shall now give a short account of the operations and architecture of the *beaver*. This amphibious quadruped is about three feet in length, and its tail, which is of an oval figure, and covered with scales, is eleven inches long. He uses his tail as a rudder to direct his course in the water. In places much frequented by man, the beavers neither associate nor build habitations. But in the northern regions of both Continents, they assemble in the month of June or July, for the purposes of uniting into society and of building a city. From all quarters they arrive in numbers, and soon form a troop of two or three hundred. The operations and architecture of the beavers are so well described by the Count de Buffon, that we shall lay it before our readers nearly in his own words. The place of rendezvous, he remarks, is generally the situation fixed upon for their establishment, and it is always on the banks of waters. If the waters be flat, and seldom rise above their ordinary level, as in lakes, the beavers make no bank or dam. But
in

in rivers or brooks, where the water is subject to risings and fallings, they build a bank, which traverses the river from one side to the other, like a sluice, and is often from 80 to 100 feet long, by 10 or 12 broad at the base. This pile, for animals of so small a size, appears to be enormous, and presupposes an incredible labour*. But the solidity with which the work is constructed is still more astonishing than its magnitude. The part of the river where they erect this bank is generally shallow. If they find on the margin a large tree, which can be made to fall into the river, they begin, by cutting it down, to form the principal basis of their work. This tree is often thicker than a man's body. By gnawing it at the bottom with their four cutting teeth, they in a short time accomplish their purpose, and always make the tree fall across the river. They next cut the branches from the trunk to make it lie level. These operations are performed by the joint industry of the whole community. Some of them, at the same time, traverse the banks of the river, and cut down

* The largest beavers weigh only 50 or 60 pounds.

smaller trees, from the size of a man's leg to that of his thigh. These they cut to a certain length, dress them into stakes, and first drag them by land to the margin of the river, and then by water to the place where the building is carrying on. These piles they sink down, and interweave the branches with the larger stakes. In performing this operation many difficulties are to be surmounted. In order to dress these stakes, and to put them in a situation nearly perpendicular, some of the beavers must elevate, with their teeth, the thick ends against the margin of the river, or against the cross tree, while others plunge to the bottom, and dig holes with their fore-feet to receive the points that they may stand on end. When some are labouring in this manner, others bring earth, which they plash with their feet, and beat firm with their tails. They carry the earth in their mouths, and with their fore-feet. They transport earth in such quantities, that they fill with it all the intervals between the piles. These piles consist of several rows of stakes, of equal height, all placed opposite to each other, and extend from one bank of the river to the other. The
stakes

stakes facing the under part of the river are placed perpendicularly; but those which are opposed to the stream slope upward to sustain the pressure of the water; so that the bank, which is ten or twelve feet wide at the base, is reduced to two or three at the top. Near the top, or thinnest part of the bank, the beavers make two or three sloping holes, to allow the surface-water to escape. These they enlarge or contract in proportion as the river rises or falls; and, when any breaches are made in the bank by sudden or violent inundations, they know how to repair them when the water subsides.

Hitherto all these operations were performed by the united force and dexterity of the whole community. They now separate into smaller societies, who build cabins or houses. These cabins are constructed upon piles near the margin of the river or pond, and have two openings, one for the animals going to the land, and the other for throwing themselves into the water. The form of these edifices is either round or oval, and they vary in size from four or five to eight or ten feet in diameter. Some of them consist of three or four stories. Their walls are

about two feet thick; and are raised perpendicularly upon planks, or upon plain stakes, which serve both for foundations and floors to their houses. When they consist of but one story, they rise perpendicularly a few feet only, afterwards assume a curved form, and terminate in a dome or vault, which answers the purpose of a roof. They are built with amazing solidity, and neatly plastered with a kind of stucco both within and without. In the application of this mortar the tails of the beavers serve for trowels, and their feet for plashing. Their houses are impenetrable to rain, and resist the most impetuous winds. In their construction, they employ different materials, as wood, stone, and a kind of sandy earth, which is not liable to be dissolved in water. The wood they use is generally of the light and tender kinds, as alders, poplars, and willows, which commonly grow on the banks of rivers, and are more easily barked, cut, and transported, than the heavier and more solid species of timber. They always begin the operation of cutting trees at a foot or a foot and a half above the ground: They labour in a sitting posture; and, beside the convenience of this posture, they enjoy the pleasure

pleasure of gnawing perpetually the bark and wood, which are their favourite food. Of these provisions they lay up ample stores in their cabins to support them during the winter. Each cabin has its own magazine, which is proportioned to the number of its inhabitants, who have all a common right to the store, and never pillage their neighbours. Some villages are composed of twenty or twenty-five cabins. But these large establishments are not frequent; and the common republics seldom exceed ten or twelve families, of which each have their own quarter of the village, their own magazine, and their separate habitation. The smallest cabins contain two, four, or six, and the largest eighteen, twenty, and sometimes thirty beavers. As to males and females, they are almost always equally paired. Upon a modern computation, therefore, the society is often composed of 150 or 200, who all, at first, labour jointly in raising the great public building, and afterwards, in select tribes or companies, in making particular habitations. In this society, however numerous, an universal peace is maintained. Their union is cemented by common labours; and it is perpetuated by mutual

mutual conveniency, and the abundance of provisions which they amass and consume together. A simple taste, moderate appetites, and an aversion to blood and carnage, render them destitute of the ideas of rapine and of war. Friends to each other, if they have any foreign enemies they know how to avoid them. When danger approaches, they advertise one another, by striking their broad tail on the surface of the water, the noise of which is heard at a great distance, and resounds through all the vaults of their habitations. Each individual, upon these occasions, consults his own safety; some plunge into the water; others conceal themselves within their walls, which can be penetrated only by the fire of heaven, or the steel of man, and which no animal will attempt either to open or to overturn. These retreats are not only safe, but neat and commodious. The floors are spread over with verdure: The branches of the box and of the fir serve them for carpets, upon which they permit not the smallest dirtiness. The window that faces the water answers for a balcony to receive the fresh air, and for the purpose of bathing. During the greater part of the day, the beavers

vers fit on end, with their head and the anterior parts of their body elevated, and their posterior parts sunk in the water. The aperture of this window is sufficiently raised to prevent its being stopped up with the ice, which, in the beaver climates, is often two or three feet thick. When this accident happens, they slope the sole of the window, cut obliquely the stakes which support it, and thus open a communication with the unfrozen water. They often swim a long way under the ice. The continual habit of keeping their tail and posterior parts of their body in the water, appears to have changed the nature of their flesh; for that of their anterior parts, as far as the reins, has the taste and consistence of the flesh of land animals; but that of the tail and posterior parts has the odour and all the other qualities of fish. The tail, which is a foot long, an inch thick, and five or six inches broad, is a genuine portion of a fish attached to the body of a quadruped: It is wholly covered with scales, and below the scales with a skin perfectly similar to that of large fishes. In September, the beavers collect their provisions of bark and of wood. Till the end of winter, they remain in their
cabins,

cabins, enjoy the fruits of their labours, and taste the sweets of domestic happiness. This is their time of repose, and their season of love. Knowing and loving one another, each couple unite, not by chance, but by taste and a real selection. The females bring forth in the end of winter, and generally produce two or three at a time. About this period they are left by the males, who retire to the country to enjoy the pleasures and the fruits of the spring. They return occasionally, however, to their cabins; but dwell there no more. The mothers continue in the cabins, and are occupied in nursing, protecting, and rearing their young, which in a few weeks are in a condition to follow their dams. The beavers assemble not again till autumn, unless their banks or cabins be injured by inundations; for, when accidents of this kind happen, they suddenly collect their forces, and repair the breaches that have been made.

This account of the society and operations of beavers, however marvellous it may appear, has been established and confirmed by so many credible eye-witnesses, that it is impossible to doubt of its reality.

The

The habitation where *moles* deposit their young merits a particular description; because it is constructed with peculiar intelligence, and because the mole is an animal with which we are well acquainted. They begin by raising the earth, and forming a pretty high arch. They leave partitions, or a kind of pillars, at certain distances, beat and press the earth, interweave it with the roots of plants, and render it so hard and solid, that the water cannot penetrate the vault, on account of its convexity and firmness. They then elevate a little hillock under the principal arch; upon the latter they lay herbs and leaves for a bed to their young. In this situation they are above the level of the ground, and, of course, beyond the reach of ordinary inundations. They are, at the same time, defended from the rains by the large vault that covers the internal one, upon the convexity of which last they rest along with their young. This internal hillock is pierced on all sides with sloping holes, which descend still lower, and serve as subterraneous passages for the mother to go in quest of food for herself and her offspring. These by-paths are beaten and firm, extend about twelve or fifteen paces, and

and issue from the principal mansion like rays from a center. Under the superior vault we likewise find remains of the roots of the meadow saffron, which seem to be the first food given to the young. From this description it appears, that the mole never comes abroad but at considerable distances from her habitation. Moles, like the beavers, pair; and so lively and reciprocal an attachment subsists between them, that they seem to disrelish all other society. In their dark abodes they enjoy the placid habits of repose and of solitude, the art of securing themselves from injury, of almost instantaneously making an asylum or habitation, and of procuring a plentiful subsistence without the necessity of going abroad. They shut up the entrance of their retreats, and seldom leave them, unless compelled by the admission of water, or when their mansions are demolished by art.

The nidification of *Birds* has at all times deservedly called forth the admiration of mankind. In general, the nests of birds are built with an art so exquisite, that an exact imitation of them exceeds all the powers of human skill and industry. Their style of
architecture,

architecture, the materials they employ, and the situations they select, are as various as the different species. Individuals of the same species, whatever region of the globe they inhabit, collect the same materials, arrange and construct them in the same form, and make choice of similar situations for erecting their temporary habitations; for the nests of birds, those of the eagle-kind excepted, after the young have come to maturity, are for ever abandoned by the parents.

To describe minutely the nests of birds would be a vain attempt. Such descriptions could not convey an adequate idea of their architecture to a person who had never seen one of those beautiful and commodious habitations, which even astonish and excite the amazement of children.

The different orders of birds exhibit great variety in the materials and structure of their nests. Those of the rapacious tribes are in general rude, and composed of coarse materials, as dried twigs, bents, &c. But they are often lined with soft substances. They build in elevated rocks, ruinous and sequestered castles and towers, and in other
solitary

solitary retirements. The aiery or nest of the eagle is quite flat, and not hollow, like those of other birds. The male and female commonly place their nest between two rocks, in a dry and inaccessible situation. The same nest, it is said, serves the eagle during life. The structure is so considerable, and composed of such solid materials, that it may last many years. Its form resembles that of a floor. Its basis consists of sticks about five or six feet in length, which are supported at each end, and these are covered with several layers of rushes and heath. An eagle's nest was found in the Peak of Derbyshire, which Willoughby describes in the following manner: 'It was made of great sticks, resting 'one end on the edge of a rock, the other on 'a birch tree. Upon these was a layer of 'rushes, and over them a layer of heath, and 'on the heath rushes again; upon which lay 'one young, and an addle egg; and by them 'a lamb, a hare, and three heath pouts. The 'nest was about two yards square, and 'had no hollow in it.' But the butcher-birds, or shrikes, which are less rapacious than eagles and hawks, build their habitations in shrubs and bushes, and employ moss, wool, and other soft materials.

The

The birds belonging to the order of *Pies* in the ingenious Mr. Pennant's Genera of Birds, are extremely irregular in constructing their nests. The common magpies build their nests in trees, and their structure is admirably contrived for affording warmth and protection to the young. The nest is not open at top: It is covered, in the most dexterous manner, with an arch or dome, and a small opening in the side of it is left to give the parents an opportunity of passing in and out at their pleasure. To protect their eggs and young from the attacks of other animals, the magpies place, all round the external surface of their nest, sharp briars and thorns. The long-tailed titmouse, or ox-eye, builds nearly like the wren, but with still greater art. With the same materials as the rest of the structure, the titmouse builds an arch over the top of the nest, which resembles an egg erected upon one end, and leaves a small hole in the side for a passage. Both eggs and young, by this contrivance, are defended from the injuries of the air, rain, cold, &c. That the young may have a soft and warm bed, she lines the inside of the nest with feathers, down, and cobwebs. The sides
and

and roof are composed of moss and wool interwoven in the most curious and artificial manner.

In treating of instinct, it was mentioned, that, in warm climates, many small birds suspended their nests on tender twigs of trees, to prevent them from being destroyed by the monkeys. In Europe, there are only three birds which build penfile nests, namely, the common oriola, the *parus pendulinus*, or hang-nest titmouse; and another penfile nest, belonging to some unknown bird, was lately discovered by Mr. Pennant, near the house of Blair in Athole, in the north of Scotland. 'In a spruce fir-tree,' Mr. Pennant remarks, 'was a hang-nest of some unknown bird, 'suspended at the four corners to the boughs. 'It was open at top, an inch and a half diameter, and two deep; the sides and bottom 'thick; the materials, moss, worsted, and 'birch bark, lined with feathers*.'

Mr. Pennant, in his Indian Zoology, gives the following curious account of the manner in which the *motacilla futoria*, or taylor bird, builds its nest. 'Had providence,' Mr. Pen-

* Pennant's Tour, vol. I. page 104. 3d. edit.

nant remarks, ' left the feathered tribes un-
' endowed with any particular instinct, the
' birds of the torrid zone would have built
' their nests in the same unguarded manner
' as those of Europe; but there the lesser
' species, having a certain prescience of the
' dangers that surround them, and of their
' own weakness, suspend their nests at the ex-
' treme branches of the trees: They are con-
' scious of inhabiting a climate replete with
' enemies to them and their young; with
' snakes that twine up the bodies of the trees,
' and apes that are perpetually in search of
' prey; but, heaven-instructed, they elude
' the gliding of the one, and the activity of
' the other.---The brute creation are more
' at enmity with one another than in other
' climates; and the birds are obliged to exert
' an unusual artifice in placing their little
' broods out of the reach of an invader. Each
' aims at the same end, though by different
' means; some form their pensile nest in
' shape of a purse, deep and open at top,
' others with a hole in the side, and others,
' still more cautious, with an entrance at
' the very bottom, forming their lodge near
' the

' the fummit* But the taylor bird seems
 ' to have greater diffidence than any of the
 ' others: It will not trust its nest even to
 ' the extremity of a slender twig, but makes
 ' one more advance to safety by fixing it to
 ' the leaf itself. It picks up a dead leaf,
 ' and, surprising to relate, sews it to the side
 ' of a living one†, its slender bill being its
 ' needle, and its thread some fine fibres, the
 ' lining feathers, gossamer, and down. Its
 ' eggs are white, the colour of the bird light
 ' yellow; its length three inches; its weight
 ' only three sixteenths of an ounce; so that
 ' the materials of the nest, and its own size,
 ' are not likely to draw down a habitation
 ' that depends on so slight a tenure §.'

Birds of the gallinaceous or poultry kind
 lay their eggs on the ground. Some of them
 scrape a kind of hole in the earth, and line
 it with a little long grass or straw.

* This instinct prevails also among the birds on the banks of
 the Gambia, in Africa, which abounds with monkeys and snakes;
 others, for the same end, make their nest in holes of the banks
 that overhang that vast river. Purchas, vol. II. page 1576.

† A nest of this bird is preserved in the British Museum.

§ Pennant's Indian Zoology, page 7.

It

It is a singular, though a well-attested fact, that the cuckow makes no nest, and neither hatches nor feeds her own young. 'The hedge-sparrow,' says Mr. Willoughby, 'is the cuckow's nurse, but not the hedge-sparrow only, but also ring-doves, larks, finches. I myself, with many others, have seen a wag-tail feeding a young cuckow. The cuckow herself builds no nest; but having found the nest of some little bird, she either devours or destroys the eggs she there finds, and, in the room thereof, lays one of her own, and so forsakes it. The silly bird returning, sits on this egg, hatches it, and, with a great deal of care and toil, broods, feeds, and cherishes the young cuckow for her own, until it be grown up and able to fly and shift for itself. Which thing seems so strange, monstrous, and absurd, that for my part I cannot sufficiently wonder there should be such an example in Nature; nor could I ever have been induced to believe that such a thing had been done by Nature's instinct, had I not with mine own eyes seen it. For Nature, in other things, is wont constantly to observe one and the same law and order,

‘agreeable to the highest reason and prudence; which in this case is, that the dams make nests for themselves, if need be, fit upon their own eggs, and bring up their own young after they are hatched*.’ This oeconomy, in the history of the cuckow, is not only singular, but seems to contradict one of the most universal laws established among animated beings, and particularly among the feathered tribes, namely, the hatching and rearing of their offspring. Still, however, like the ostrich in very warm climates, though the cuckow neither hatches nor feeds her young, she places her eggs in situations where they are both hatched and her offspring brought to maturity. Here the stupidity of the one animal makes it a dupe to the rapine and chicane of the other; for the cuckow always destroys the eggs of the small bird before she deposits her own.

Most of the passerine or small tribes build their nests in hedges, shrubs, or bushes; though some of them, as the lark and the goat-fucker, build upon the ground. The nests of small birds are more delicate in

* Willoughby's Ornithology, page 98.

their structure and contrivance than those of the larger kinds. As the size of their bodies, and likewise that of their eggs, are smaller, the materials of which their nests are composed are generally warmer. Small bodies retain heat a shorter time than those which are large. Hence the eggs of small birds require a more constant supply of heat than those of greater dimensions. Their nests, accordingly, are built proportionally warmer and deeper, and they are lined with softer substances. The larger birds, of course, can leave their eggs for some time with impunity; but the smaller kinds sit most assiduously; for, when the female is obliged to go abroad in quest of food, the nest is always occupied by the male. When a nest is finished nothing can exceed the dexterity of both male and female in concealing it from the observation of man, and of other destructive animals. If it is built in bushes, the pliant branches are disposed in such a manner as to hide it entirely from view. To conceal her retreat the chaffinch covers the outside of her nest with moss, which is commonly of the same colour with the bark of the tree on which she builds. The common

swallow builds its nest on the tops of chimneys; and the martin attaches her's to the corners of windows, or under the eaves of houses. Both employ the same materials. The nest is built with mud well tempered by the bill, and moistened with water to make it more firmly cohere; and the mud or clay is kept still firmer by a mixture of straw or grass. Within it is neatly lined with feathers. Willoughby, on the authority of Bontius, informs us, ' That on the sea coast
' of the kingdom of China, a sort of small
' party-coloured birds, of the shape of swallows, at a certain season of the year, viz.
' their breeding time, come out of the mid-
' land country to the rocks; and, from the
' foam or froth of the sea-water dashing and
' breaking against the bottom of the rocks,
' gather a certain clammy, glutinous matter,
' perchance the sperm of whales, or other
' fishes, of which they build their nests, where-
' in they lay their eggs, and hatch their young.
' These nests the Chinese pluck from the
' rocks, and bring them in great numbers
' into the East Indies to sell; which are
' esteemed by gluttons great delicacies, who,
' dissolving them in chicken or mutton broth,
' are

‘are very fond of them, preferring them far
‘before oysters, mushrooms, or other dainty
‘and lickerish morsels which most gratify
‘the palate.---These nests are of a hemispherical figure, of the bigness of a goose-egg, and of a substance resembling ising-glass*.’

Most of the cloven-footed water-fowls, or waders, lay their eggs upon the ground. But the spoon-bills and the common heron build large nests in trees, and employ twigs and other coarse materials; and the storks build on churches, or on the tops of houses. Many of the web-footed fowls lay their eggs likewise on the ground, as the terns, and some of the gulls and mergansers. But ducks pull the down from their own breasts to afford a warmer and more comfortable bed for their young. The auks, the guillemots, and the puffins or coulternebs, lay their eggs on the naked shelves of high rocks. The penguins, for the same purpose, dig large and deep holes under ground.

It is not unworthy of remark, that birds uniformly proportion the dimensions of their

* Willoughby's Ornithology, page 215.

nefts to the number and size of the young to be produced. Every species lays nearly a determined number of eggs. But, if one be each day abstracted from the nest, the bird continues to lay daily more till her number is completed. Dr. Lister, by this practice, made a swallow lay no less than nineteen eggs.

The habitations of *Insects* are next to be considered. On this branch of the subject we shall first give some examples of abodes constructed by solitary workers, and next of those habitations which are executed by associated numbers.

In several preceding parts of this work, and particularly in the chapter upon Instinct, the reader will find some instances of the skill and industry exhibited by insects for the convenient lodging and protection of their young. These it is unnecessary to repeat. We shall therefore proceed to give some examples of a different kind.

There are several species of bees distinguished by the appellation of *solitary*, because they do not associate to carry on any joint operations. Of this kind is the *mason-bee*, so called because it builds a habitation composed of sand and mortar. The nests of this
bee

bee are fixed to the walls of houses, and, when finished, have the appearance of irregular prominences arising from dirt or clay accidentally thrown against a wall or stone by the feet of horses. These prominencies are not so remarkable as to attract attention ; but, when the external coat is removed, their structure is discovered to be truly admirable. The interior part consists of an assemblage of different cells, each of which affords a convenient lodgment to a white worm, pretty similar to those produced by the honey-bee. Here they remain till they have undergone all their metamorphoses. In constructing this nest, which is a work of great labour and dexterity, the female is the sole operator. She receives no assistance from the male. The manner in which the female mason-bees build their nests is the most curious branch of their history.

After choosing a part of a wall on which she is resolved to fix an habitation for her future progeny, she goes in quest of proper materials. The nest to be constructed must consist of a species of mortar, of which sand is the basis. She knows, like human builders, that every kind of sand is not equally proper for making good mortar. She goes, therefore, to a bed of sand,

sand, and selects, grain by grain, the kind which is best to answer her purpose. With her teeth, which are as large and as strong as those of the honey-bee, she examines and brings together several grains. But sand alone will not make mortar. Recourse must be had to a cement similar to the slacked lime employed by masons. Our bee is unacquainted with lime, but she possesses an equivalent in her own body. From her mouth she throws out a viscid liquor, with which she moistens the first grain pitched upon. To this grain she cements a second, which she moistens in the same manner, and to the former two she attaches a third, and so on, till she has formed a mass as large as the shot usually employed to kill hares. This mass she carries off in her teeth to the place she had chosen for erecting her nest, and makes it the foundation of the first cell. In this manner she labours incessantly till the whole cells are completed, a work which is generally accomplished in five or six days. All the cells are similar, and nearly equal to dimensions. Before they are covered their figure resembles that of a thimble. She never begins to make a second till the first be finished.

Each

Each cell is about an inch high, and nearly half an inch in diameter. But the labour of building is not the only one this female bee has to undergo. When a cell has been raised to one half or two-thirds of its height another occupation commences. She seems to know the quantity of food that will be necessary to nourish the young that is to proceed from the egg, from its exclusion till it acquires its full growth, and passes into the chrysalis state. The food which is prepared for the support of the young worm consists of the farina or powder of flowers, diluted with honey, which forms a kind of pap. Before the cell is entirely finished the mason-bee collects from the flowers, and deposits in the cell, a large quantity of farina, and afterwards disgorges upon it as much honey as dilutes it, and forms it into a kind of paste or syrup. When this operation is performed she completes her cell, and, after depositing an egg in it, covers the mouth of it with the same mortar she uses in building her nest. The egg is now enclosed on all sides in a walled habitation hermetically sealed. A small quantity of air, however, gets admission to the worm, otherwise it could not exist.

Reaumur

Reaumur discovered that air actually penetrated through this seemingly compact mason-work.

As soon as the first cell is completed the mason-bee lays the foundation of another. In the same nest she often constructs seven or eight cells, and sometimes only three or four. She places them near each other, but not in any regular order. This industrious animal, after all her cells are constructed, filled with provisions, and sealed, covers the whole with an envelope of the same mortar, which, when dry, is as hard as a stone. The nest now is commonly of an oblong or roundish figure, and the external cover is composed of coarser sand than that of the cells. As the nests are almost as durable as the walls on which they are placed, they are often, in the following season, occupied and repaired by a stranger bee. Though inclosed with two hard walls, when the fly emerges from the chrysalis state, it first gnaws with its teeth a passage through the wall that sealed up the mouth of its cell; afterwards, with the same instruments, it pierces the still stronger and more compact cover which invests the whole nest; at last it escapes
into

into the open air, and, if a female, in a short time constructs a nest of the same kind with that which the mother had made. To all these facts, Du Hamel, Reaumur, and many other naturalists of credit and reputation, have been repeatedly eye-witnesses.

From the hardness of the materials with which the mason-bee constructs her nest, from the industry and dexterity she employs to protect her progeny from enemies of every kind, one should naturally imagine that the young worms were in perfect safety, and that their castle was impregnable. But, notwithstanding all these favourable precautions, the young of the mason-bee are often devoured by the instinctive dexterity of certain species of four-winged insects, distinguished by the name of *ichneumon flies*. These flies, when the mason-bee has nearly completed a cell, and filled it with provisions, deposit their own eggs in her cell. After the eggs of the ichneumon flies are hatched, their worms devour not only the provisions laid up by the mason-bee, but even her progeny whom she had laboured so hard, and with so much art and ingenuity,

nuity, to protect. But the mason-bee has an enemy still more formidable. A certain fly employs the same stratagem of insinuating an egg into one of her cells before it is completed. From this egg proceeds a strong and rapacious worm, armed with prodigious fangs. The devastations of this worm are not confined to one cell. He often pierces through each cell in the nest, and successively devours both the mason-worms, and the provisions so anxiously laid up for their support by the mother. This stranger-worm is afterwards transformed into a fine beetle, who is enabled to pierce the nest, and to make his escape.

The operation of another species of solitary bees, called *wood-piercers*, merit attention. These bees are larger than the queens of the honey-bee. Their bodies are smooth, except the sides, which are covered with hair. In the spring they frequent gardens, and search for rotten, or at least dead wood, in order to make an habitation for their young. When a female of this species, for she receives no assistance from the male, has selected a piece of wood, or a decayed tree, she commences her labour by making a hole
in

in it, which is generally directed toward the axis of the tree. When she has advanced about half an inch she alters the direction of the hole, and conducts it nearly parallel to the axis of the wood. The size of her body requires that this hole should have a considerable diameter. It is often so large as to admit the finger of a man, and it sometimes extends from twelve to fifteen inches in length. If the thickness of the wood permits, she makes three or four of these long holes in its interior part. M. de Reaumur found three of these parallel holes in an old espalier post. Their diameters exceeded half an inch. This labour, for a single bee, is prodigious; but, in executing it, she consumes weeks, and even months.

Around the foot of a post or piece of wood where one of these bees are working, little heaps of timber-dust are always found lying on the ground. These heaps daily increase in magnitude, and the particles of dust are as large as those produced by a hand-saw. The two teeth with which the animal is provided are the only instruments she employs in making such considerable perforations. Each tooth consists of a solid piece of shell, which
in

which in shape resembles an augur. It is convex above, concave below, and terminates in a sharp but strong point.

These long holes are designed for lodgings to the worms that are to proceed from the eggs which the bee is soon to deposit in them. But, after the holes are finished, her labour is by no means at an end. The eggs must not be mingled, or piled above each other. Every separate worm must have a distinct apartment, without any communication with the others. Each long hole or tube, accordingly, is only the outer walls of a house which is to consist of many chambers ranged one above another. A hole of about twelve inches in length she divides into ten or twelve separate apartments, each of which is about an inch high. The roof of the lowest room is the floor of the second, and so on to the uppermost. Each floor is about the thickness of a French crown. The floors or divisions are composed of particles of wood cemented together by a glutinous substance from the animal's mouth. In making a floor she commences with gluing an annular plate of wood-dust round the internal circumference of the cavity. To this plate she attaches
a second,

a second, to the second a third, and to the third a fourth, till the whole floor is completed. The undermost cell requires only a roof, and this roof is a floor to the second, &c.

We have hitherto described the wonderful assiduity of this animal in constructing her cells. But this operation, though great, and seemingly superior to the powers of a creature so small, is not her only labour. Before roofing in the first cell she fills it with a paste or pap, composed of the farina of flowers moistened with honey. The quantity of paste is equal to the dimensions of the cell, which is about an inch high, and half an inch in diameter. Into this paste, which is to nourish the future worm, she deposits an egg. Immediately after this operation she begins to form a roof, which not only incloses the first cell, but serves as a floor to the second. The second cell she likewise fills with paste, deposits an egg, and then covers the whole with another roof. In this manner she proceeds till she has divided the whole tube into separate cells. A single tube frequently contains from ten to a dozen of these cells. When the cells are all inclosed
the

the business of this laborious bee is finished, and she takes no more charge of her future progeny. The attention and solicitude bestowed by many other animals, in rearing their young, are exerted after birth. But, in the wood-piercing bee, as well as in many other insects, this instinctive attachment is reversed. All her labours and all her cares are exerted before she either sees her offspring, or knows that they are to exist. But, after the description that has been given of her amazing operations, she will not be considered as an unnatural mother. With astonishing industry and perseverance, she not only furnishes her young with safe and convenient lodgings, but lays up for them stores of provisions sufficient to support them till their final metamorphosis into flies, when the new females perform the same almost incredible operations for the protection and sustenance of their own offspring. When the young worm is hatched it has scarcely sufficient space to turn itself in the cell, which is almost entirely filled with the pappy substance formerly mentioned. But, as this substance is gradually devoured by the worm, the space in the cell necessarily enlarges in proportion to the growth and magnitude of the animal.

We

We are informed by M. de Reaumur*, that M. Pitot furnished him with a piece of wood, not exceeding an inch and a half in diameter, which contained the cells of a wood-piercing bee. He cut off as much of the wood as was sufficient to expose two of the cells to view, in each of which was a worm. The aperture he had made, to prevent the injuries of the air, he closed, by pasting on it a bit of glass. The cells were then almost entirely filled with paste. The two worms were exceedingly small, and, of course, occupied but little space between the walls of the cells and the mass of paste. As the animals increased in size the paste daily diminished. He began to observe them on the 12th day of June; and, on the 27th of the same month, the paste in each cell was nearly consumed, and the worm, folded in two, occupied the greater part of its habitation. On the 2d of July the provisions of both worms were entirely exhausted; and, beside the worms themselves, there remained in the cells only a few small, black, oblong grains of excrement. The five or six follow-

* Tom. 11. page 58. 12mo. edit.

ing days they fasted, which seemed to be a necessary abstinence, during which they were greatly agitated. They often bended their bodies, and elevated and depressed their heads. These movements were preparatory to the great change the animals were about to undergo. Between the 7th and 8th of the same month they threw off their skins, and were metamorphosed into nymphs. On the 30th of July these nymphs were transformed into flies similar to their parents. In a range of cells the worms are of different ages, and, of course, of different sizes. Those in the lower cells are older than those in the superior; because, after the bee has filled with paste and enclosed its first cell, a considerable time is requisite to collect provisions, and to form partitions for every successive and superior cell. The former, therefore, must be transformed into nymphs and flies before the latter. These circumstances are apparently foreseen by the common mother; for, if the undermost worm, which is oldest, and soonest transformed, were to force its way upward, which it could easily do, it would not only disturb, but infallibly destroy all those lodged in the superior cells.

But

But Nature has wisely prevented this devastation; for the head of the nymph, and consequently of the fly, is always placed in a downward direction. Its first instinctive movements must, therefore, be in the same direction. That the young flies may escape from their respective cells the mother digs a hole at the bottom of the long tube, which makes a communication with the undermost cell and the open air. Sometimes a similar passage is made near the middle of the tube. By this contrivance, as all the flies instinctively endeavour to cut their way downward, they find an easy and convenient passage; for they have only to pierce the floor of their cells, which they readily perform with their teeth.

Another small species of solitary bees dig holes in the earth to make a convenient habitation for their young. Their nests are composed of cylindrical cells fixed to one another, and each of them, in figure, resembles a thimble. Their bottom, of course, is convex and rounded. The bottom of the second is inserted into the entry of the first; and the entry of the second receives the bottom of the third. They are not all of the same

I 2 length.

length. Some of them are five lines long, others only four, and their diameters seldom exceed two lines. Sometimes only two of these cells are joined together; and, at other times, we find three or four, which form a kind of cylinder. This cylinder is composed of alternate bands of two different colours: Those of the narrowest, at the juncture of two cells, are white, and those of the broadest are of a reddish brown. The cells consist of a number of fine membranes, formed of a glutinous and transparent substance from the animal's mouth. Each cell our bee fills with the farina of flowers diluted with honey, and in this paste she deposits an egg. She then covers the cell, by gluing to its mouth a fine cellular substance taken from the leaves of some plant; and in this manner she proceeds till her cylindrical nest is completed. The worms which are hatched from the eggs feed upon the paste, so carefully laid up for them by the mother, till they are transformed into flies similar to their parents.

Among wasps, as well as bees, there are solitary species, which carry on no joint operations. These solitary wasps are not less ingenious in constructing proper habitations for their young,

young, nor less provident in laying up for them a store of nourishment sufficient to support them till they are transformed into flies, or have become perfect animals. But to give a detailed description of their operations would lead us into a prolixity of which the plan of our work does not admit.

On this subject, however, it cannot escape observation, that all the sagacity and laborious industry exerted in the various instances of animal architecture above described, have one uniform tendency. They are all designed for the multiplication, protection, and nourishment of offspring. But many of them are so artful, and require such persevering labour, that the human mind is bewildered when it attempts to account for them. If we attend to the operations of quadrupeds, of birds, and of insects, most of them, like pregnant women, seem to know, from their own feelings, and foresight, not only their present condition, but what futurity is to produce. To solve this problem, recourse has been had by Des Cartes, by Buffon, and by other philosophers, to conformation of body and mechanical impulse. Their reasonings, however, though often ingenious, involve the subject in tenfold obscurity. We can

can hardly suppose that the animals actually foresee what is to happen, because, at first, they have not had even the aid of experience; and, particularly in some of the insect tribes, the parents are dead before their young are produced. Pure instincts of this kind, therefore, must be referred to another source. In a chain of reasoning concerning the operations of Nature, such is the constitution of our minds, that we are under the necessity of resorting to an ultimate cause. What that cause is, it is the highest presumption in man to pretend to define. But, though we must for ever remain ignorant of the cause, we are enabled to trace, and even to understand, partially, some of the effects; and, from these effects, we perceive the most consummate wisdom, the most elegant and perfect contrivances, to accomplish the multifarious and wonderful intentions of Nature. In contemplating the operations of animals, from man down to the seemingly most contemptible insect, we are necessarily compelled to refer them to pure instincts, or original qualities of mind, variegated by Nature according as the necessities, preservation, and continuation of the different species require. Let any man try to proceed a step farther, and,

and, however he may deceive himself, and flatter his own vanity, he must find, at last, that he is clouded in obscurity, and that men who have a more correct and unprejudiced mode of thinking will brand him with absurdity, and of acting in direct opposition to the constitution and frame of the human mind.

I shall now give some examples of the operations of associating insects, who construct habitations by exerting a common and mutual labour.

The skill and dexterity of the *honey-bees*, displayed in the construction of their combs or nests, have at all times called forth the admiration of mankind. They are composed of cells regularly applied to each other's sides. These cells are uniform hexagons or six-sided figures. In a bee-hive, every part is arranged with such symmetry, and so finely finished, that, if limited to the same materials, the most expert workman would find himself unqualified to construct a similar habitation, or rather a similar city.

Most Natural Historians have celebrated bees for their wisdom, for the perfection and harmony of their republican government, and for their persevering industry and wonderful
oeconomy.

oeconomy. All these splendid talents, however, the late ingenious Count de Buffon has endeavoured to persuade us, are only results of pure mechanism. But this is not the proper place to enter into a discussion of this point. It will fall more naturally to be treated of when we come to describe the societies established among different gregarious animals. We shall therefore, at present, confine ourselves chiefly to the mode in which bees construct their habitations.

In the formation of their combs bees seem to resolve a problem which would not be a little puzzling to some geometers, namely, A quantity of wax being given, to make of it equal and similar cells of a determined capacity, but of the largest size in proportion to the quantity of matter employed, and disposed in such a manner as to occupy in the hive the least possible space. Every part of this problem is completely executed by the bees. By applying hexagonal cells to each other's sides no void spaces are left between them; and, though the same end might be accomplished by other figures, yet they would necessarily require a greater quantity of wax. Besides, hexagonal cells are better fitted to receive the cylindrical

cylindrical bodies of these insects. A comb consists of two strata of cells applied to each other's ends. This arrangement both saves room in the hive, and gives a double entry into the cells of which the comb is composed. As a farther saving of wax, and preventing void spaces, the bases of the cells in one stratum of a comb serve for bases to the opposite stratum. In a word, the more minutely the construction of these cells are examined, the more will the admiration of the observer be excited. The walls of the cells are so extremely thin, that their mouths would be in danger of suffering by the frequent entering and issuing of the bees. To prevent this disaster, they make a kind of ring round the margin of each cell, and this ring is three or four times thicker than the walls.

It is difficult to perceive, even with the assistance of glass-hives, the manner in which bees operate when constructing their cells. They are so eager to afford mutual assistance, and, for this purpose, so many of them crowd together, and are perpetually succeeding each other, that their individual operations can seldom be distinctly observed. It has, however, been plainly discovered; that their two
teeth

teeth are the only instruments they employ in modelling and polishing the wax. With a little patience and attention, we perceive cells just begun : We likewise remark the quickness with which a bee moves its teeth against a small portion of the cell. This portion the animal, by repeated strokes on each side, smooths, renders compact, and reduces to a proper thinness of consistence. While some of the hive are lengthening their hexagonal tubes, others are laying the foundations of new ones. In certain circumstances, when extremely hurried, they do not complete their new cells, but leave them imperfect till they have begun a number sufficient for their present exigencies. When a bee puts its head a little way into a cell, we easily perceive it scraping the walls with the points of its teeth, in order to detach such useless and irregular fragments as may have been left in the work. Of these fragments the bee forms a ball about the size of a pin-head, comes out of the cell, and carries this wax to another part of the work where it is needed. It no sooner leaves the cell than it is succeeded by another bee, which performs the same office, and in this manner

manner the work is successively carried on till the cell is completely polished.

The cells of bees are designed for different purposes. Some of them are employed for the accumulation and preservation of honey. In others, the female deposits her eggs, and from these eggs worms are hatched, which remain in the cells till their final transformation into flies. The drones or males are larger than the common or working bees; and the queen, or mother of the hive, is much larger than either. A cell destined for the lodgement of a male or female worm must, therefore, be considerably larger than the cells of the smaller working bees. The number of cells destined for the reception of the working bees far exceeds those in which the males are lodged. The honey-cells are always made deeper and more capacious than the others. When the honey collected is so abundant that the vessels cannot contain it, the bees lengthen, and of course deepen the honey-cells.

Their mode of working, and the disposition and division of their labour, when put into an empty hive, do much honour to the sagacity of bees. They immediately begin to lay the foundations of their combs, which they execute

cute with surprising quickness and alacrity. Soon after they begin to construct one comb, they divide into two or three companies, each of which, in different parts of the hive, is occupied with the same operations. By this division of labour a greater number of bees have an opportunity of being employed at the same time, and, consequently, the common work is sooner finished. The combs are generally arranged in a direction parallel to each other. An interval or street between the combs is always left, that the bees may have a free passage, and an easy communication with the different combs in the hive. These streets are just wide enough to allow two bees to pass one another. Beside these parallel streets, to shorten their journey when working, they leave several round cross passages, which are always covered.

Hitherto we have chiefly taken notice of the manner in which bees construct and polish their cells, without treating of the materials they employ. We have not marked the difference between the crude matter collected from flowers and the true wax. Every body knows that bees carry into their hives, by means of their hind thighs, great quantities of the farina

rina or dust of flowers. After many experiments made by Reaumur, with a view to discover whether this dust contained real wax, he was obliged to acknowledge, that he could never find that wax formed any part of its composition. He at length discovered that wax was not a substance produced by the mixture of farina with any glutinous substance, nor by trituration, or any mechanical operation. By long and attentive observation he found that the bees actually eat the farina which they so industriously collect; and that this farina, by an animal process, is converted into wax. This digestive process, which is necessary to the formation of wax, is carried on in the second stomach, and perhaps in the intestines of bees. After knowing the place where this operation is performed, chymists will probably allow, that it is equally difficult to make real wax with the farina of flowers, as to make chyle with animal or vegetable substances, a work which is daily executed by our own stomach and intestines, and by those of other animals. Reaumur likewise discovered that all the cells in a hive were not destined for the reception of honey, and for depositing the eggs of the female, but that some of them were employed

employed as receptacles for the farina of flowers, a species of food that bees find necessary for the formation of wax, which is the great basis and raw material of all their curious operations. When a bee comes to the hive with its thighs filled with farina, it is often met near the entrance by some of its companions, who first take off the load, and then devour the provisions so kindly brought to them. But, when none of the bees employed in the hive are hungry for this species of food, the carriers of the farina deposit their loads in cells prepared for that purpose. To these cells the bees resort when the weather is so bad that they cannot venture to go to the fields in quest of fresh provisions. The carrying bees, however, commonly enter the hive loaded with farina. They walk along the combs beating and making a noise with their wings. By these movements they seem to announce their arrival to their companions. No sooner has a loaded bee made these movements than three or four of those within leave their work, come up to it, and first take off its load, and then eat the materials it has brought. As a farther evidence that the bees actually eat the farina of flowers, when the stomach and
intestines

intestines are laid open, they are often found to be filled with this dust, the grains of which, when examined by the microscope, have the exact figure, colour, and consistence of farina, taken from the antherae of particular flowers. After the farina is digested, and converted into wax, the bees possess the power of bringing it from their stomachs to their mouths. The instrument they employ in furnishing materials for constructing their waxen cells is their tongue. This tongue is situated below the two teeth or fangs. When at work the tongue may be seen by the assistance of a lens and a glass-hive. It is then in perpetual motion, and its motions are extremely rapid. Its figure continually varies. Sometimes it is more sharp, at others it is flatter, and sometimes it is more or less concave, and partly covered with a moist paste or wax. By the different movements of its tongue the bee continues to supply fresh wax to the two teeth, which are employed in raising and fashioning the walls of its cell, till they have acquired a sufficient height. As soon as the moist paste or wax dries, which it does almost instantaneously, it then assumes all the appearances and qualities of common wax. There is a still stronger

stronger proof that wax is the result of an animal process. When bees are removed into a new hive, and closely confined from the morning to the evening, if the hive chances to please them, in the course of this day several waxen cells will be formed, without the possibility of a single bee's having had access to the fields. Besides, the rude materials, or the farina of plants, carried into the hive, are of various colours. The farina of some plants employed by the bees is whitish; in others it is of a fine yellow colour; in others it is almost entirely red; and in others it is green. The combs constructed with these differently coloured materials are, however, uniformly of the same colour. Every comb, especially when it is newly made, is of a pure white colour, which is more or less tarnished by age, the operation of the air, or by other accidental circumstances. To bleach wax, therefore, requires only the art of extracting such foreign bodies as may have insinuated themselves into its substance and changed its original colour.

Bees, from the nature of their constitution, require a warm habitation. They are likewise extremely solicitous to prevent insects

sects of any kind from getting admittance into their hives. To accomplish both these purposes, when they take possession of a new hive, they carefully examine every part of it, and, if they discover any small holes or chinks, they immediately paste them firmly up with a resinous substance which differs considerably from wax. This substance was not unknown to the ancients. Pliny mentions it under the name of *propolis*, or bee-glue. Bees use the propolis for rendering their hives more close and perfect, in preference to wax, because the former is more durable, and more powerfully resists the vicissitudes of weather than the latter. This glue is not, like wax, procured by an animal process. The bees collect it from different trees, as the poplars, the birches, and the willows. It is a complete production of Nature, and requires no addition or manufacture from the animals by which it is employed. After a bee has procured a quantity sufficient to fill the cavities in its two hind thighs, it repairs to the hive. Two of its companions instantly draw out the propolis, and apply it to fill up such chinks, holes, or other deficiencies, as they find in their habitation. But

this is not the only use to which bees apply the propolis. They are extremely solicitous to remove such insects or foreign bodies as happen to get admission into the hive. When so light as not to exceed their powers, they first kill the insect with their stings, and then drag it out with their teeth. But it sometimes happens that an ill-fated snail creeps into the hive. It is no sooner perceived than it is attacked on all sides and stung to death. But how are the bees to carry out a burden of such weight? This labour they know would be in vain. They are perhaps apprehensive that a body so large would diffuse, in the course of its putrefaction, a disagreeable or noxious odour through the hive. To prevent such hurtful consequences, immediately after the animal's death, they embalm it, by covering every part of its body with propolis, through which no effluvia can escape. When a snail with a shell gets entrance, to dispose of it gives much less trouble and expence to the bees. As soon as this kind of snail receives the first wound from a sting, it naturally retires within its shell. In this case, the bees, instead of pasting it all over with propolis,

polis, content themselves with gluing all round the margin of the shell, which is sufficient to render the animal for ever immoveably fixed.

But propolis, and the materials for making wax, are not the only substances these industrious animals have to collect. As formerly remarked, beside the whole winter, there are many days in summer in which the bees are prevented by the weather from going abroad in quest of provisions. They are, therefore, under the necessity of collecting, and amassing in cells destined for that purpose, large quantities of honey. This sweet and balsamic liquor they extract, by means of their proboscis or trunk, from the nectariferous glands of flowers. The trunk of a bee is a kind of rough cartilaginous tongue. After collecting a few small drops of honey, the animal with its proboscis conveys them to its mouth and swallows them. From the oesophagus or gullet, it passes into the first stomach, which is more or less swelled in proportion to the quantity of honey it contains. When empty, it has the appearance of a fine white thread: But when filled with honey, it

K 2

assumes

assumes the figure of an oblong bladder, the membrane of which is so thin and transparent, that it allows the colour of the liquor it contains to be distinctly seen. This bladder is well known to children who live in the country. They cruelly amuse themselves with catching bees, and tearing them asunder, in order to suck the honey. A single flower furnishes but a small quantity of honey. The bees are, therefore, obliged to fly from one flower to another till they fill their first stomachs. When they have accomplished this purpose, they return directly to the hive, and disgorge in a cell the whole honey they have collected. It not unfrequently happens, however, that, when on its way to the hive, it is accosted by a hungry companion. How the one can communicate its necessity to the other, it is perhaps impossible to discover. But the fact is certain, that, when two bees meet in this situation, they mutually stop, and the one whose stomach is full of honey extends its trunk, opens its mouth, which lies a little beyond the teeth, and, like ruminating animals, forces up the honey into that cavity. The hungry bee knows how to take advantage
of

of this hospitable invitation. With the point of its trunk it sucks the honey from the other's mouth. When not stopped on the road, the bee proceeds to the hive, and in the same manner offers its honey to those who are at work, as if it meant to prevent the necessity of quitting their labour in order to go in quest of food. In bad weather the bees feed upon the honey laid up in open cells; but they never touch these reservoirs when their companions are enabled to supply them with fresh honey from the fields. But the mouths of those cells which are destined for preserving honey during winter, they always cover with a lid or thin plate of wax.

Though not strictly connected with the present subject, we cannot refrain from giving some account of the ingenious Mr. Debray's discoveries concerning the sex of bees, and the manner in which their species is multiplied*. It was almost universally believed, both by ancients and moderns, that bees, like other animals, propagated by an actual intercourse of the male and female,

* See Philosophical Transactions, ann. 1777, Part I. page 15.

though

though it never could be perceived by the most attentive observers. Pliny remarks, that *apium coitus visus est nunquam*; and even the indefatigable Reaumur, notwithstanding the many minute researches and experiments he made concerning every part of the oeconomy of bees, and though he represents the mother, or queen-bee, as a perfect Messalina, could never detect an actual intercourse. From this singular circumstance, Maraldi, in his observations upon bees †, conjectured that the eggs of bees, like those of fishes, were impregnated after they were deposited in the cells by the mother. He was farther confirmed in his opinion, by uniformly observing that a whitish liquid substance surrounded each egg which turned out to be fertile; but that those eggs round which no such substance was to be found were always barren. The working bees, or those which collect from flowers the materials of wax, have generally been considered as belonging to neither sex. But Mr. Schirach, a German Naturalist, in his *History of the Queen of the Bees*, maintains, that all the common

† Hist. de l'Acad. de Scien. ann. 1712.

bees are females in a disguised or barren state; that the organs which distinguish the sex, and particularly the ovaria, are either obliterated, or, on account of their minuteness, have not hitherto been discovered; that, in the early period of its existence, every one of these bees is capable of becoming a queen-bee, if the community choose to nurse it in a certain manner, and to raise it to that distinguished rank; and that the queen-bee lays only two kinds of eggs, namely, those that are to produce drones or males, and those from which the working bees are to proceed.

The conjecture of Maraldi concerning the impregnation of the eggs after they are deposited in the cells, as well as the observations of Mr. Schirach concerning the sex of the working bees, have been completely verified by the experiments of Mr. Debrow. Both Maraldi and Reaumur had long ago discovered, that, in every hive, beside the large drones, there are males or drones as small as the working bees. By means of glass hives, Mr. Debrow observed, that the queen-bee begins to deposit her eggs in the cells on the fourth or fifth day after the bees begin to work. On the

the first or second day after the eggs are placed in the cells, he perceived several bees sinking the posterior parts of their bodies into each cell, where they continued but a short time. After they had retired, he saw plainly with the naked eye a small quantity of whitish liquor left in the bottom of each cell that contained an egg. Next day he found that this liquor was absorbed into the egg, which, on the fourth day, is hatched. When the worms escape from the eggs, they are fed for eight or ten days with honey by the working bees. After that period they shut up the mouths of the cells, where the worms continue enclosed for ten days more, during which time they undergo their different transformations.

‘ I immersed,’ says Mr. DeBrow, ‘ all the
‘ bees in water; and, when they appeared to
‘ be in a senseless state, I gently pressed every
‘ one of them between my fingers, in order
‘ to distinguish those armed with stings from
‘ those that had none, which last I might
‘ suspect to be males. Of these I found sixty-
‘ seven exactly of the size of common bees,
‘ yielding a little whitish liquor on being
‘ pressed between the fingers. I killed every
‘ one,

‘ one, and replaced the swarm in a glass-hive,
 ‘ where they immediately applied again to
 ‘ the work of making cells; and, on the
 ‘ fourth or fifth day, very early in the morn-
 ‘ ing, I had the pleasure to see the queen-bee
 ‘ depositing her eggs in those cells, which she
 ‘ did by placing the posterior part of her body
 ‘ in each of them. I continued to watch
 ‘ most part of the ensuing days, but could
 ‘ discover nothing of what I had seen before.
 ‘ The eggs, after the fourth day, instead of
 ‘ changing in the manner of caterpillars,
 ‘ were found in the same state they were in
 ‘ the first day.’ The next day about noon,
 the whole swarm forsook the hive, probably
 because the animals perceived, that, without
 the assistance of males, they were unqualifi-
 ed to multiply their species. To show the
 necessity of the eggs being fecundated by the
 male influence, Mr. Debrau relates an experi-
 ment still more decisive.

‘ I took,’ says he, ‘ the brood-comb, which,
 ‘ as I observed before, had not been impreg-
 ‘ nated. I divided it into two parts; one I
 ‘ placed under a glass-bell, No. 1. with ho-
 ‘ ney-comb for the bees food; I took care to
 ‘ leave a queen, but no drones, among the
 ‘ common

• common bees I confined in it. The other
‘ piece of brood-comb I placed under ano-
‘ ther glass-bell, No. 2. with a few drones, a
‘ queen, and a number of common bees pro-
‘ portioned to the size of the glass. The re-
‘ sult was, that, in the glass No. 1. no im-
‘ pregnation happened ; the eggs remained in
‘ the same state they were in when put into
‘ the glass ; and, upon giving the bees their
‘ liberty on the seventh day, they all flew
‘ away, as was found to be the case in the
‘ former experiment : Whereas, in the glass
‘ No. 2. I saw, the very day after the bees had
‘ been put under it, the impregnation of the
‘ eggs by the drones in every cell containing
‘ eggs ; the bees did not leave their hive
‘ on receiving their liberty ; and, in the
‘ course of twenty days, every egg under-
‘ went all the above-mentioned necessary
‘ changes, and formed a pretty numerous
‘ young colony, in which I was not a little
‘ startled to find *two* queens.’

The appearance of a new queen in a hive where there was no large or royal cell, made Mr. Debrow conjecture that the bees are capable, by some particular means, of transforming a common subject into a queen.

To

To ascertain the truth of this conjecture he provided himself with four glass-hives, into each of which he put a piece of brood-comb taken from an old hive. These pieces of brood-comb contained eggs, worms, and nymphs. In each hive he confined a sufficient number of common bees, and some drones or males, but took care that there should be no queen.

‘ The bees,’ Mr. Debrush remarks, ‘ finding themselves without a queen, made a strange buzzing noise, which lasted near two days, at the end of which they settled, and betook themselves to work. On the fourth day I perceived in each hive the beginning of a royal cell, *a certain indication that one of the inclosed worms would soon be converted into a queen.* The construction of the royal cell being nearly accomplished, I ventured to leave an opening for the bees to get out, and found that they returned as regularly as they do in common hives, and shewed no inclination to leave their habitation. But, to be brief, at the end of twenty days I observed four young queens among the new progeny.’

To

To these experiments of Mr. Debraw, it was objected, that the queen-bee, beside the eggs which she deposits in the royal cells, might likewise have laid royal or female eggs in the common cells; and that the pieces of brood-comb, so successfully employed in his experiments for the production of a queen, had always happened to contain one of these royal eggs, or rather one of the worms proceeding from them. But this objection was afterwards removed by many other accurate experiments, the results of which were uniformly the same; and the objectors to Mr. Debraw's discovery candidly admit, that, when the community stands in need of a queen, the working-bees possess the power of raising a common subject to the throne, and that every worm of the hive is capable, under a certain course of management, of becoming the mother of a numerous progeny. This metamorphosis seems to be chiefly accomplished by a peculiar nourishment carefully administered to the worm by the working-bees, by which, and perhaps by other unknown means, the female organs, the germs of which previously existed in the embryo, are expanded, and all those differences

rences in form and size, that so remarkably distinguish the queen from the working-bees, are produced.

It is always a fortunate circumstance when discoveries, which at first seem calculated solely to gratify curiosity, are capable of being turned to the advantage of society. Mr. Debrow, accordingly, has not failed to point out the advantages that may be derived from his researches into the oeconomy and nature of bees. By his discovery, we are taught an easy mode of multiplying, without end, swarms, or new colonies, of these useful insects. Beside the great increase of honey, if this discovery were sufficiently attended to, considerable sums annually expended in importing wax into this kingdom from the Continent might be saved. The practice of this new art, Mr. Schirach informs us, has already extended itself through Upper Lusatia, the Palatinate, Bohemia, Bavaria, Silesia, and Poland. In some of these countries it has excited the attention, and acquired the patronage, of government. The Empress of Russia, who never loses sight of a single article by which the industry, and, of course, the happiness of her subjects can be augmented, has

has sent a proper person to Klein Bautzen to be instructed in the general principles, and to learn all the minutiae of this new and important art.

Wasps, like the bees, associate in great numbers, and construct, with much dexterity and skill, a common habitation. There are many species of wasps, some of which unite into societies, and others spend their lives in perfect solitude. But, in this place, we shall confine our attention to the operations of the common associating wasp, an insect so well known, even to children, that it requires no description. Though bees, as well as wasps, are armed with a sting, yet the former may be regarded as a placid and harmless race. Bees are continually occupied with their own labours. Their chief care is to defend themselves; and they never take nourishment at the expence of any other animal. Wasps, on the contrary, are ferocious animals, who live entirely on rapine and destruction. They kill and devour every insect that is inferior to them in strength. But, though warlike and rapacious in their general manners, they are polished and peaceable among themselves. To their young, they discover the greatest tenderness and

and affection. For their protection and conveniency no labour is spared ; and the habitations they construct do honour to their patience, address, and sagacity. Their architecture, like that of the honey-bee, is singular, and worthy of admiration ; but the materials employed furnish neither honey nor wax. Impelled by an instinctive love of posterity, they, with great labour, skill, and assiduity, construct combs, which are likewise composed of hexagonal or six-sided cells. Though these cells are not made of wax, they are equally proper for the reception of eggs, and for affording convenient habitations to the worms which proceed from them till their transformation into wasps.

In general, the cells of the wasps are formed of a kind of paper, which, with great dexterity, is fabricated by the animals themselves. The number of combs and cells in a wasp's nest is always proportioned to the number of individuals associated. Different species choose different situations for building their nests. Some expose their habitations to all the injuries of the air ; others prefer the trunks of decayed trees ; and others, as the common kind, of which we
are

are principally treating, conceal their nests under ground. The hole which leads to a wasp's nest is about an inch in diameter. This hole is a kind of gallery mined by the wasps, is seldom in a straight line, and varies in length from half a foot to two feet, according to the distance of the nest from the surface of the ground. When exposed to view, the whole nest appears to be of a roundish form, and sometimes about twelve or fourteen inches in diameter. It is strongly fortified all round with walls or layers of paper, the surface of which is rough and irregular. In these walls, or rather in this external covering, two holes are left for passages to the combs. The wasps uniformly enter the nest by one hole, and go out by the other, which prevents any confusion or interruption to their common labours.

We are now arrived at the gates of this subterraneous city, which, though small, is extremely populous. Upon removing the external covering, we perceive that the whole interior part consists of several storeys or floors of combs, which are parallel to each other, and nearly in a horizontal position. Every storey is composed of a numerous assemblage of
of

of hexagonal cells, very regularly constructed with a matter resembling ash-coloured paper. These cells contain neither wax nor honey, but are solely destined for containing the eggs, the worms which are hatched from them, the nymphs, and the young wasps till they are able to fly. Wasps nests are not always composed of an equal number of combs. They sometimes consist of fifteen, and sometimes of eleven only. The combs are of various diameters. The first, or uppermost, is often only two inches in diameter, while those of the middle sometimes exceed a foot. The lowest are also much smaller than the middle ones. All these combs, like so many floors or storeys ranged parallelly above each other, afford lodging to prodigious numbers of inhabitants. Reaumur computed, from the number of cells in a given portion of comb, that, in a medium sized nest, there were at least 10,000 cells. This calculation gives an idea of the astonishing prolific powers of these insects, and of the vast numbers of individuals produced in a single season from one nest; for every cell serves as a lodging to no less than three generations. Hence a moderately

sized nest gives birth annually to 30,000 young wasps.

The different storeys of combs are always about half an inch high, which leaves free passages to the wasps from one part of the nest to another. These intervals are so spacious, that, in proportion to the bulk of the animals, they may be compared to great halls, or broad streets. Each of the larger combs is supported by about fifty pillars, which, at the same time, give solidity to the fabric, and greatly ornament the whole nest. The lesser combs are supported by the same ingenious contrivance. These pillars are coarse, and of a roundish form. Their bases and capitals, however, are much larger in diameter than towards the middle. By the one end they are attached to the superior comb, and by the other to the inferior. Thus between two combs there is always a species of rustic colonade. The wasps begin at the top and build downward. The uppermost and smallest comb is first constructed. It is attached to the superior part of the external covering. The second comb is fixed to the bottom of the first; and in this manner the animals proceed till the whole operation is completed.

completed. The connecting pillars are composed of the same kind of paper as the rest of the nest. To allow the wasps entries into the void spaces roads are left between the combs and the external envelope or covering.

Having given a general idea of this curious edifice, it is next natural to inquire how the wasps build, and how they employ themselves in their abodes. But, as all these mysteries are performed under the earth, it required much industry and attention to discover them. By the ingenuity and perseverance of M. de Reaumur, however, we are enabled to explain some parts of their internal oeconomy and manners. This indefatigable naturalist contrived to make wasps, like the honey-bees, lodge and work in glass hives. In this operation he was greatly assisted by the ardent affection which these animals have to their offspring; for he found, that, though the nest was cut in different directions, and though it was exposed to the light, the wasps never deserted it, nor relaxed in their attention to their young. When placed in a glass-hive, they are perfectly peaceable, and never attack the observer, if he calmly contemplates their operations;

ations; for, naturally, they do not sting, unless they are irritated.

Immediately after a wasp's nest has been transported from its natural situation, and covered with a glass-hive, the first operation of the insects is to repair the injuries it has suffered. With wonderful activity they carry off all the earth and foreign bodies that may have accidentally been conveyed into the hive. Some of them occupy themselves fixing the nest to the top and sides of the hive by pillars of paper similar to those which support the different stories or strata of combs; others repair the breaches it has sustained; and others fortify it by augmenting considerably the thickness of its external cover. This external envelope is an operation peculiar to wasps. Its construction requires great labour; for it frequently exceeds an inch and a half in thickness, and is composed of a number of strata or layers as thin as paper, between each of which there is a void space. This cover is a kind of box for inclosing the combs, and defending them from the rain which occasionally penetrates the earth. For this purpose it is admirably adapted. If it were one solid mass, the con-

tact

taet of water would penetrate the whole, and reach the combs. But to prevent this fatal effect, the animals leave considerable vacuities between each vaulted layer, which are generally fifteen or sixteen in number. By this ingenious piece of architecture, one or two layers may be moistened with water, while the others are not in the least affected.

The materials employed by wasps in the construction of their nests are very different from those made use of by the honey-bee. Instead of collecting the farina of flowers, and digesting it into wax, the wasps gnaw with their two fangs, which are strong and serrated, small fibres of wood from the sashes of windows, the posts of espaliers, garden doors, &c. but never attempt growing or green timber. These fibres, which, though very slender, are often a line, or a twelfth part of an inch long. After cutting a certain number of them, the animals collect them into minute bundles, transport them to their nest, and, by means of a glutinous substance furnished from their own bodies, form them into a moist and ductile paste. Of this substance, or *papier maché*, they construct the external cover, the
partitions

partitions of the nest, the hexagonal cells, and the solid columns which support the several layers or stories of combs.

The constructing of the nest occupies a comparatively small number of labourers. The others are differently employed. Here it is necessary to remark, that the republics of wasps, like those of the honey-bees, consist of three kinds of flies, males, females, and neuters. Like the bees, also, the number of neuters far surpasses those of both males and females. The greatest quantity of labour is devolved upon the neuters; but they are not, like the neuter bees, the only workers; for there is no part of their different operations which the females, at certain times, do not execute. Neither do the males, though their industry is not comparable to that of the neuters, remain entirely idle. They often occupy themselves in the interior part of the nest. The greatest part of the labour, however, is performed by the neuters. They build the nest, feed the males, the females, and even the young. But, while the neuters are employed in these different operations, the others are abroad in hunting parties. Some attack with intrepidity live insects, which they sometimes carry
entire

entire to the nest; but they generally transport the abdomen or belly only. Others pillage butchers stalls, from which they often arrive with a piece of meat larger than the half of their own bodies. Others resort to gardens, and suck the juices of fruits. When they return to the nest they distribute a part of their plunder to the females, to the males, and even to such neuters as have been usefully occupied at home. As soon as a neuter enters the nest it is surrounded by several wasps, to each of whom it freely gives a portion of the food it has brought. Those who have not been hunting for prey, but have been sucking the juices of fruits, though they seem to return empty, fail not to regale their companions; for, after their arrival, they station themselves upon the upper part of the nest, and discharge from their mouths two or three drops of a clear liquid, which are immediately swallowed by the domestics.

The neuter wasps, though the most laborious, are the smallest; but they are extremely active and vivacious. The females are much larger, heavier, and slower in their movements. The males are of an intermediate size between that of the females and neuters.

ters. From these differences in size it is easy to distinguish the different kinds of those wasps which build their nests below the ground. In the hive of the honey-bee the number of females is always extremely small; but, in a wasp's nest, there are often more than three hundred females. During the months of June, July, and August, they remain constantly in the nest, and are never seen abroad except in the beginning of spring, and in the months of September and October. During the summer they are totally occupied in laying their eggs and feeding their young. In this last operation they are assisted by the other wasps; for the females alone, though numerous, would be insufficient for the laborious task. A wasp's nest, when completed, sometimes consists of sixteen thousand cells, each of which contains an egg, a worm, or a nymph. The eggs are white, transparent, of an oblong figure, and differ in size, according to the kind of wasps which are to proceed from them. Some of them are no larger than the head of a small pin. They are so firmly glued to the bottoms of the cells, that it is with difficulty they can be detached without breaking. Eight days after the
the

the eggs are deposited in the cells the worms are hatched, and are considerably larger than the eggs which gave birth to them. These worms demand the principal cares of the wasps who continue always in the nest. They feed them, as birds feed their young, by giving them, from time to time, a mouthful of food. It is astonishing to see with what industry and rapidity a female runs along the cells of a comb, and distributes to each worm a portion of nutriment. In proportion to the ages and conditions of the worms they are fed with solid food, such as the bellies of insects, or with a liquid substance disgorged by the mother. When a worm is so large as to occupy its whole cell, it is then ready to be metamorphosed into a nymph. It then refuses all nourishment, and ceases to have any connection with the wasps in the nest. It shuts up the mouth of its cell with a fine filken cover, in the same manner as the silk-worm and other caterpillars spin their cods. This operation is completed in three or four hours, and the animal remains in the nymph state nine or ten days, when, with its teeth, it destroys the external cover of the cell, and comes forth
in

in the form of a winged insect, which is either male, female, or neuter, according to the nature of the egg from which it was hatched. In a short time, the wasps newly transformed receive the food brought into the nest by the foragers in the fields. What is still more curious, in the course of the first day after their transformation the young wasps have been observed going to the fields, bringing in provisions, and distributing them to the worms in the cells. A cell is no sooner abandoned by a young wasp, than it is cleaned, trimmed, and repaired by an old one, and rendered, in every respect, proper for the reception of another egg.

As formerly mentioned, wasps of different sexes differ greatly in size. The animals know how to construct cells proportioned to the dimensions of the fly that is to proceed from the egg which the female deposits in them. The neuters are six times smaller than the females, and their cells are built nearly in the same proportion. Cells are not only adapted for the reception of neuters, males, and females, but it is remarkable that the cells of the neuters are never intermixed with those

those of the males or females. A comb is entirely occupied with small cells fitted for the reception of neuter worms. But male and female cells are often found in the same comb. The males and females are of equal length, and, of course, require cells of an equal deepness. But the cells of the males are narrower than those of the females, because the bodies of the former are never so thick as those of the latter.

This wonderful assemblage of combs, of the pillars which support them, and of the external envelope, is an edifice which requires several months labour, and serves the animals one year only. This habitation, so populous in summer, is almost deserted in winter, and abandoned entirely in spring; for, in this last season, not a single wasp is to be found in a nest of the preceding year. It is worthy of remark, that the first combs of a nest are always accommodated for the reception of the neuter or working wasps. The city, of which the foundation has just been laid, requires a number of workmen. The neuter or working wasps are accordingly first produced. A cell is no sooner half completed than an egg of a neuter is deposited in it by the female.

male. Of fourteen or fifteen combs inclosed in a common cover, the four last only are destined for the reception of males and females. Hence it uniformly happens, that, before the males and females are capable of taking flight, every wasp's nest is peopled with several thousand neuters or workers. But the neuters, who are first produced, are likewise the first that perish; for not one of them survives the termination even of a mild winter. It was remarked by the ancient naturalists, that some wasps lived one year only, and others two. To the former Aristotle gives the appellation of *operarii*, which are our workers or neuters, and to the latter *matrices*, which are our females.

The female wasps are stronger, and support the rigours of winter better than the males or neuters. Before the end of winter, however, several hundred females die, and not above ten or a dozen in each nest survive that season. These few females are destined for the continuation of the species. Each of them becomes the founder of a new republic. When a queen-bee departs from a hive in order to establish a new one, she is always accompanied with several thousand industrious labourers,
ready

ready to perform every necessary operation. But the female wasp has not the aid of a single labourer; for all the neuters are dead before the beginning of the spring. The female alone lays the foundation of a new republic. She either finds or digs a hole under the earth, builds cells for the reception of her eggs, and feeds the worms which proceed from them. Whenever any of these neuter worms are transformed into flies, they immediately assist their parent in augmenting the number of cells and combs, and in feeding the young worms, which are daily hatching from the eggs. In a word, this female wasp, which in spring was perfectly solitary, without any proper habitation, and had every operation to perform, has, in autumn, several thousands of her offspring at her devotion, and is furnished with a magnificent palace, or rather city, to protect her from the injuries of the weather and from external enemies.

With regard to the male wasps, it is uncertain whether any of them survive the winter. But, though not so indolent as the males of the honey-bee, they can be of little assistance to the female; for they never engage in any work of importance, such as constructing

ing cells, or fortifying the external cover of the nest. They are never brought forth till towards the end of August; and their sole occupation seems to be that of keeping the nest clean: They carry out every kind of filth, and the carcasses of such of their companions as happen to die. In performing this operation two of them often join, and, as mentioned in another place, when the load is too heavy, they cut off the head, and transport the dead animal at two times.

In the beginning of spring, when the female wasp has built her subterraneous habitation, which is soon to be peopled with thousands of flies, she has no occasion for the males; because, in the month of September or October, she had been previously impregnated. The males and females are produced at the same time, and they are nearly equal in number. Like the male honeybees, the male wasps are destitute of stings, but the females and neuters have stings, the poisonous liquor of which, when introduced into any part of the human body, excites inflammation, and creates a considerable degree of pain.

The

The habitations and the oeconomy of the common *ant* are exceedingly curious. But, as they are so well known, and so obvious to inspection and examination, we shall not detain the reader with a description of them. To supply this defect we shall give some account of the truly wonderful operations of the *termi-tes*, which are generally called *white-ants**, though they belong to a different genus of insects. These animals infest Guinea, and all the tropical regions, where, for their depredations of property, they are greatly dreaded by the inhabitants; from which circumstance they have received the name of *Fatalis* or *Destructor*.

The following abridged account of the *termi-tes*, and of the wonderful habitations they build, is selected from an excellent description of them in a Letter from Mr. Henry Smeathman, of Clement's Inn, to Sir Joseph Banks, which was published in the Philosophical Transactions†. Though the nests, or rather

* In the windward parts of Africa they are denominated *bugga*, *buggs*; in the West Indies, *wood-lice*, *wood-ants*, or *white-ants*. They are likewise called *piercers*, *eaters*, or *cutters*, because they cut almost every thing in pieces.

† Vol. 71. part 1. page 139.

hills,

hills, constructed by the termites, are mentioned by many travellers, their descriptions and observations are by no means so accurate as those of the ingenious Mr. Smeathman. Of these insects there are several species; but they all resemble each other in form, and in their manner of living. They differ, however, as much as birds, in the stile of their architecture, and in the selection of the materials of which their nests are composed. Some build on the surface, or partly above and partly below the ground, and others on the trunks or branches of lofty trees.

Before describing the nests or hills, it is necessary to give some idea of the animals themselves, and of their general oeconomy and manners. We shall confine ourselves to that species called *termites bellicosus*, or *fighters*, because they are largest, and best known on the coast of Africa.

The republic of the *termites bellicosus*, like the other species of this genus, consists of three ranks, or orders of insects: 1. The working insects, which Mr. Smeathman distinguishes by the name of *labourers*; 2. The fighters, or *soldiers*, which perform no kind
of

of labour; and, 3. The winged, or *perfect insects*, which are male and female, and capable of multiplying the species. These last Mr. Smeathman calls the *nobility* or *gentry*; because they neither labour nor fight. The nobility alone are capable of being raised to the rank of kings and queens. A few weeks after their elevation to this state, they emigrate, in order to establish new empires.

In a nest or hill, the labourers, or working insects, are always most numerous: There are at least one hundred labourers to one of the fighting insects or soldiers. When in this state, they are about a fourth of an inch in length, which is rather smaller than some of our aunts. From their figure, and fondness for wood, they are very generally known by the name of *wood-lice*.

The second order, or soldiers, differ in figure from that of the labourers. The former have been supposed to be neuters, and the latter males. But, in fact, they are the same insects. They have only undergone a change of form, and made a nearer approach to the perfect state. They are now much larger, being half an inch in length, and equal

in size to fifteen of the labourers. The form of the head is likewise greatly changed. In the labourer state, the mouth is evidently formed for gnawing or holding bodies: But, in the soldier state, the jaws being shaped like two sharp awls a little jagged, are destined solely for piercing or wounding. For these purposes they are very well calculated; for they are as hard as a crab's claw, and placed in a strong horny head, which is of a nut-brown colour, and larger than the whole body.

The figure of the third order, or that of the insect in its perfect state, is still more changed. The head, the thorax, and the abdomen, differ almost entirely from the same parts in the labourers and soldiers. Beside, the animals are now furnished with four large, brownish, transparent wings, by which they are enabled, at the proper season, to emigrate and to establish new settlements. In the winged or perfect state, they have likewise acquired the organs of generation, and are greatly altered in their size as well as in their figure. Their bodies now measure between six and seven tenths of an inch, their wings, from tip to tip, above two inches and a half, and their bulk is equal

equal to that of thirty labourers, or two soldiers. Instead of active, industrious, and rapacious little animals, when they arrive at their perfect state, they become innocent, helpless, and dastardly. Their numbers are great; but their enemies are still more numerous. They are devoured by birds, by every species of ants, by carnivorous reptiles, and even by the inhabitants of many parts of Africa. This last fact is attested by Piso, Margraave, De Laet, Konig, Moor, Sparman, and by many other travellers, as well as by Smeathman. After such devastation, it is surprising that a single pair should escape so many dangers. ‘Some, however,’ says Mr. Smeathman, ‘are so fortunate; and being found by some of the labouring insects, that are continually running about the surface of the ground under their covered galleries, are *elected Kings and Queens* of new states; all those who are not so elected and preserved certainly perish. The manner in which these labourers protect the happy pair from their innumerable enemies, not only on the day of the massacre of almost all their race, but for a long time after, will, I hope, justify me in the use of the term *election*.

‘ The little industrious creatures immediately
‘ inclose them in a small chamber of clay suitable to their size, into which, at first, they
‘ leave but one small entrance, large enough
‘ for themselves and the soldiers to go in and
‘ out, but much too little for either of the
‘ royal pair to make use of; and, when necessity obliges them to make more entrances,
‘ they are never larger; so that, of course, the
‘ *voluntary subjects* charge themselves with the
‘ task of providing for the offspring of their
‘ sovereigns, as well as to work and to fight
‘ for them, until they have raised a progeny
‘ capable at least of dividing the task with
‘ them.

‘ It is not till this, probably, that they consummate their marriage, as I never saw a
‘ pair of them joined. The business of propagation, however, soon commences; and the
‘ labourers having constructed a small wooden
‘ nursery, carry the eggs and lodge them there
‘ as fast as they can obtain them from the
‘ *queen*.

‘ About this time a most extraordinary
‘ change begins to take place in the *queen*, to
‘ which I know nothing similar, except in the
‘ *pulex penetrans* of Linnaeus, the *jigger* of the
West

‘ West Indies, and in the different species of
 ‘ *coccus, cochineal*. The abdomen of this fe-
 ‘ male begins gradually to extend and enlarge
 ‘ to such an enormous size, that an *old queen*
 ‘ will have it increased so as to be *fifteen hun-*
 ‘ *dred or two thousand times* the bulk of the
 ‘ rest of her body, and *twenty or thirty thou-*
 ‘ *sand times* the bulk of a labourer, as I have
 ‘ found by carefully weighing and computing
 ‘ the different states. The skin between the
 ‘ segments of the abdomen extends in every
 ‘ direction; and at last the segments are re-
 ‘ moved to half an inch distance from each
 ‘ other, though, at first, the length of the
 ‘ whole abdomen is not half an inch. I con-
 ‘ jecture the animal is upwards of two years
 ‘ old when the abdomen is increased to three
 ‘ inches in length: I have sometimes found
 ‘ them of near twice that size. The abdomen
 ‘ is now of an irregular oblong shape, being
 ‘ contracted by the muscles of every segment,
 ‘ and is become one vast matrix full of eggs,
 ‘ which make long circumvolutions through
 ‘ an innumerable quantity of very minute
 ‘ vessels that circulate round the inside in a
 ‘ serpentine manner, which would exercise the
 ‘ ingenuity of a skilful anatomist to dissect
 ‘ and

‘ and develope. This singular matrix is not
‘ more remarkable for its amazing extension
‘ and size than for its peristaltic motion,
‘ which resembles the undulating of waves,
‘ and continues incessantly without any appa-
‘ rent effort of the animal ; so that one part or
‘ other, alternately, is rising and sinking in
‘ perpetual succession, and the matrix seems
‘ never at rest, but is always protruding eggs
‘ to the amount (as I have frequently counted
‘ in old queens) of sixty in a minute, or eighty
‘ thousand and upwards in one day of twenty-
‘ four hours.

‘ These eggs are instantly taken from her
‘ body by her attendants, (of whom there
‘ always are, in the royal chamber and the
‘ galleries adjacent, a sufficient number in
‘ waiting), and carried to the nurseries, which,
‘ in a great nest, may some of them be four
‘ or five feet distant in a straight line, and,
‘ consequently, much farther by their winding
‘ galleries. Here, after they are hatched, the
‘ young are attended and provided with
‘ every thing necessary until they are able to
‘ shift for themselves, and take their share of
‘ the labours of the community.’

We

We shall now endeavour to give some idea of the almost incredible architecture and oeconomy of these wonderful insects.

The nests of the *termites bellicosæ*, or woodlice, are called *hills* by the natives of Africa, New Holland, and other hot climates. This appellation is highly proper; for they are often elevated ten or twelve feet above the surface of the earth, and are nearly of a conical figure. These hills, instead of being rare phenomena, are so frequent in many places near Senegal, that, as described with great propriety by Monf. Adanson, their number, magnitude, and closeness of situation, make them appear like villages of the Negroes. ‘ But of all the extraordinary things I observed,’ says Monf. Adanson, ‘ nothing struck me more than certain eminences, which, by their height and regularity, made me take them, at a distance, for an assemblage of Negroe huts, or a considerable village, and yet they were only the nests of certain insects. These nests are round pyramids, from eight to ten feet high, upon nearly the same base, with a smooth surface of rich clay, excessively hard and well
‘ built.’

‘built*.’ Jobson, in his history of Gambia, tells us, that ‘the ant-hills are remarkable
 ‘cast up in those parts by pismires, some of
 ‘them twenty foot in height, of compasse to
 ‘contayne a dozen of men, with the heat of
 ‘the sun baked into that hardnesse, that we
 ‘used to hide ourselves in the ragged toppes
 ‘of them, when we took up stands to shoot at
 ‘deere or wild beasts †.’ Mr. Bosman remarks, in his description of Guinea, that ‘the
 ‘ants make nests of the earth about twice
 ‘the height of a man ‡.’

Each of these hills is composed of an exterior and an interior part. The exterior cover is a large clay-shell, which is shaped like a dome. Its strength and magnitude are sufficient to inclose and protect the interior building from the injuries of the weather, and to defend its numerous inhabitants from the attacks of natural or accidental enemies. The external dome or cover is, therefore, always much stronger than the internal build-

* Adanson's Voyage to Senegal, 8vo. page 153—337. Voyage de Senegal, 4to. page 83—99.

† Purchas's Pilgrims, vol. 2. page 1570.

‡ Page 276—493.

ing, which is the habitation of the insects, and is divided with wonderful artifice and regularity into a vast number of apartments for the residence and accommodation of the king and queen, for the nursing of their progeny, and for magazines, which are always well stored with provisions.

These hills make their first appearance in the form of conical turrets about a foot high. In a short time, the insects erect, at a little distance, other turrets, and go on increasing their number and widening their bases, till their underworks are covered with these turrets, which the animals always raise highest in the middle of the hill, and, by filling up the intervals between each turret, collect them, at last, into one great dome.

‘ The *royal chamber*,’ Mr. Smeathman remarks, ‘ which is occupied by the king and queen, appears to be, in the opinion of this little people, of the most consequence, and is always situated as near the center of the interior building as possible, and generally about the height of the common surface of the ground. It is always nearly in the shape of half an egg, or an obtuse oval, within, and may be supposed to represent a long
‘ oven.

‘ oven. In the infant state of the colony, it
‘ is not above an inch, or thereabout, in
‘ length; but in time will be increased to six
‘ or eight inches, or more, in the clear, being
‘ always in proportion to the size of the
‘ queen, who, increasing in bulk as in age,
‘ at length requires a chamber of such dimen-
‘ sions.’

The entrances into the royal chamber will not admit any animal larger than the soldiers or labourers. Hence the *king* and the *queen*, which last, when full grown, is a thousand times the weight of a king, can never possibly go out. The royal chamber is surrounded by an innumerable quantity of others, which are of different sizes, figures, and dimensions; but all of them are arched either in a circular or an elliptical form. These chambers either open into each other, or have communicating passages, which being always clear, are evidently intended for the convenience of the soldiers and attendants, of whom, as will soon appear, great numbers are necessary. These apartments are joined by the magazines and nurseries. The magazines are chambers of clay, and are at all times well stored with provisions, which, to the naked eye, seem to consist

consist of the raspings of wood and plants which the termites destroy; but, when examined by the microscope, they are found to consist chiefly of the gums or inspissated juices of plants, thrown together in small irregular masses. Of these masses, some are finer than others, and resemble the sugar about preserved fruits; others resemble the tears of gum, one being quite transparent, another like amber, a third brown, and a fourth perfectly opaque.

The magazines are always intermixed with the nurseries, which last are buildings totally different from the rest of the apartments. They are composed entirely of wooden materials, which seem to be cemented with gums. Mr. Smeathman very properly gives them the appellation of *nurseries*; because they are invariably occupied by the eggs, and the young ones, which first appear in the shape of labourers; but they are as white as snow. These buildings are exceedingly compact, and are divided into a number of small irregular-shaped chambers, not one of which is half an inch wide. They are placed all round, and as near as possible to the royal apartments.

When

When a nest or hillock is in the infant state, the nurseries are close to the royal apartment. But as, in process of time, the body of the queen enlarges, it becomes necessary, for her accommodation, to augment the dimensions of her chamber. She then, likewise, lays a greater number of eggs, and requires more attendants; of course, it is necessary that both the number and dimensions of the adjacent apartments should be augmented. For this purpose, the small first built nurseries are taken to pieces, rebuilt a little farther off, made a size larger, and their number, at the same time, is increased. Thus the animals are continually employed in pulling down, repairing, or rebuilding their apartments; and these operations they perform with wonderful sagacity, regularity, and foresight.

One remarkable circumstance regarding the nurseries must not be omitted. They are always slightly overgrown with a kind of *mould*, and plentifully sprinkled with white globules about the size of a small pin's head. These globules, Mr. Smeathman at first conjectured to be the eggs; but, when examined by the microscope, they evidently appeared to be a species

species of mushroom, in shape resembling our eatable mushroom when young. When entire, they are white like snow a little melted and frozen again; and, when bruised, they seem to be composed of an infinite number of pellucid particles, approaching to oval forms, and are with difficulty separated from each other. The mouldiness seems likewise to consist of the same kind of substance*.

The nurseries are enclosed in chambers of clay, like those which contain the provisions; but they are much larger. In the early state of the nest, they are not bigger than an hazel nut; but, in great hills, they are often as large as a child's head of a year old.

The royal chamber is situated nearly on a level with the surface of the ground, at an equal distance from all the sides of the building, and directly under the apex of the hill. On all sides, both above and below, it is sur-

* Mr. Konig, who examined the termites nests in the East Indies, conjectures, that these mushrooms are the food of the young insects. This supposition implies, that the old ones have a method of providing for and promoting the growth of the mushroom; 'a circumstance,' Mr. Smeathman remarks, 'which, however strange to those unacquainted with the sagacity of those insects, I will venture to say, from many other extraordinary facts I have seen of them, is not very improbable.'

rounded

rounded by what are called the *royal apartments*, which contain only labourers and soldiers, who can be intended for no other purpose than to continue in the nest either to guard or serve their common *father* and *mother*, on whose safety the happiness, and, in the estimation of the Negroes, the existence of the whole community depends. These apartments compose an intricate labyrinth, which extends a foot or more in diameter from the *royal chamber* on every side. Here the nurseries and magazines of provisions begin; and, being separated by small empty chambers and galleries, which surround them, and communicate with each other, are continued on all sides to the outward shell, and reach up within it two-thirds or three-fourths of its height, leaving an open area in the middle under the dome, which resembles the nave of an old cathedral. This area is surrounded by large Gothic arches, which are sometimes two or three feet high next the front of the area, but diminish rapidly as they recede, like the arches of aisles in perspectives, and are soon lost among the innumerable chambers and nurseries behind them. All these chambers and passages are arched, and contribute mutually

tually to support one another. The interior building, or assemblage of nurseries, chambers, and passages, has a flattish roof without any perforation. By this contrivance, if, by accident, water should penetrate the external dome, the apartments below are preserved from injury. The area has also a flattish floor, which is situated above the royal chamber. It is likewise water-proof, and so constructed, that, if water gets admittance, it runs off by subterraneous passages, which are of an astonishing magnitude. 'I measured one of them,' says Mr. Smeathman. 'which was perfectly cylindrical, and thirteen inches in diameter.' These subterraneous passages are thickly lined with the same kind of clay of which the hill is composed, ascend the internal part of the external shell in a spiral form, and, winding round the whole building up to the top, intersect and communicate with each other at different heights. From every part of these large galleries a number of pipes, or smaller galleries, leading to different apartments of the building, proceed. There are likewise a great many which lead downward, by sloping descents, three and four feet perpendicular under ground, among the gravel, from which
the

the labouring termites select the finer parts, which, after being worked up in their mouths to the consistence of mortar, become that solid clay or stone of which their hills and every apartment of their buildings, except the nurseries, are composed. Other galleries ascend and lead out horizontally on every side, and are carried under ground, but near the surface, to great distances. Suppose the whole nests within a hundred yards of a house were completely destroyed, the inhabitants of those at a greater distance will carry on their subterraneous galleries, and invade the goods and merchandizes contained in it by sap and mine, unless great attention and circumspection are employed by the proprietor.

Mr. Smeathman concludes his description of the habitations of the *termites bellicosus*, with much modesty, in the following words: ‘ Thus I have described, as briefly
‘ as the subject would admit, and I trust
‘ without exaggeration, those wonderful build-
‘ ings, whose size, and external form, have
‘ often been mentioned by travellers, but
‘ whose interior, and most curious parts are
‘ so little known, that I may venture to
‘ consider

‘ consider my account of them as new, which
‘ is the only merit it has ; for they are con-
‘ structed upon so different a plan from
‘ any thing else upon the earth, and so
‘ complicated, that I cannot find words equal
‘ to the task.’

When a breach is made in one of the hills by an ax, or other instrument, the first object that attracts attention is the behaviour of the soldiers, or fighting insects. Immediately after the blow is given, a soldier comes out, walks about the breach, and seems to examine the nature of the enemy, or the cause of the attack. He then goes in to the hill, gives the alarm, and, in a short time, large bodies rush out as fast as the breach will permit. It is not easy to describe the fury these fighting insects discover. In their eagerness to repel the enemy, they frequently tumble down the sides of the hill, but recover themselves very quickly, and bite every thing they encounter. This biting, joined to the striking of their forceps upon the building, makes a crackling or vibrating noise, which is somewhat shriller and quicker than the ticking of a watch, and may be heard at

the distance of three or four feet. While the attack proceeds, they are in the most violent hustle and agitation. If they get hold of any part of a man's body, they instantly make a wound, which discharges as much blood as is equal to their own weight. When they attack the leg, the stain of blood upon the stocking extends more than an inch in width. They make their hooked jaws meet at the first stroke, and never quit their hold, but suffer themselves to be pulled away leg by leg, and piece after piece, without the smallest attempt to escape. On the other hand, if a person keeps out of their reach, and gives them no farther disturbance, in less than half an hour they retire into the nest, as if they supposed the wonderful monster that damaged their castle had fled. Before the whole soldiers have got in, the labouring insects are all in motion, and hasten toward the breach, each of them having a quantity of tempered mortar in his mouth. This mortar they stick upon the breach as fast as they arrive, and perform the operation with so much dispatch and facility, that, notwithstanding

withstanding the immensity of their numbers, they never stop or embarrass one another. During this scene of apparent hurry and confusion, the spectator is agreeably surpris'd when he perceives a regular wall gradually arising and filling up the chasm. While the labourers are thus employed, almost all the soldiers remain within, except here and there one, who saunters about among six hundred or a thousand labourers, but never touches the mortar. One soldier, however, always takes his station close to the wall that the labourers are building. This soldier turns himself leisurely on all sides, and, at intervals of a minute or two, raises its head, beats upon the building with his forceps, and makes the vibrating noise formerly mentioned. A loud hiss instantly issues from the inside of the dome and all the subterraneous caverns and passages. That this hiss proceeds from the labourers is apparent; for, at every signal of this kind, they work with redoubled quickness and alacrity. A renewal of the attack, however, instantly changes the scene. ‘ On the

‘ first stroke,’ Mr. Smeathman remarks,
‘ the labourers run into the many pipes
‘ and galleries with which the building is
‘ perforated, which they do so quickly,
‘ that they seem to vanish; for in a few
‘ seconds all are gone, and the soldiers
‘ rush out as numerous and as vindictive
‘ as before. On finding no enemy, they
‘ return again leisurely into the hill, and,
‘ very soon after, the labourers appear
‘ loaded as at first, as active, and as sedulous,
‘ with soldiers here and there among
‘ them, who act just in the same manner,
‘ one or other of them giving the signal
‘ to hasten the business. Thus the pleasure
‘ of seeing them come out to fight or
‘ to work, alternately, may be obtained as
‘ often as curiosity excites, or time permits;
‘ and it will certainly be found, that the one
‘ order never attempts to fight, or the
‘ other to work, let the emergency be ever so
‘ great.’

It is exceedingly difficult to explore the interior parts of a nest or hill. The apartments which surround the royal chamber and the nurseries, and indeed the whole fabrick, have such a dependence on each other,

other, that the breaking of one arch generally pulls down two or three. There is another great obstacle to our researches, namely, the obstinacy of the soldiers, who, says our author, ‘ fight to the very last, ‘ disputing every inch of ground so well as ‘ often to drive away the Negroes who ‘ are without shoes, and make white people bleed plentifully through their stockings. Neither can we let a building ‘ stand so as to get a view of the interior parts without interruption; for, while ‘ the soldiers are defending the out-works, ‘ the labourers keep barricading all the way ‘ against us, stopping up the different ‘ galleries and passages which lead to the ‘ various apartments, particularly the royal ‘ chamber, all the entrances to which they ‘ fill up so artfully as not to let it be ‘ distinguishable while it remains moist; and, ‘ externally, it has no other appearance ‘ than that of a shapeless lump of clay. ‘ It is, however, easily found from its situation with respect to the other parts of the ‘ building, and by the crowds of labourers ‘ and soldiers which surround it, who ‘ show their loyalty and fidelity by dying under

‘ under its walls. The royal chamber, in a
‘ large nest, is capacious enough to hold
‘ many hundreds of the attendants, besides
‘ the royal pair; and you always find it as
‘ full of them as it can hold. These faith-
‘ ful subjects never abandon their charge
‘ even in the last distress; for, whenever I
‘ took out the royal chamber, and, as I
‘ often did, preserved it for some time in a
‘ large glass bowl, all the attendants con-
‘ tinued running in one direction round the
‘ king and queen with the utmost solicitude,
‘ some of them stopping at the head of the
‘ latter, as if to give her something. When
‘ they came to the extremity of the abdo-
‘ men, they took the eggs from her, and
‘ carried them away, and piled them care-
‘ fully together in some part of the cham-
‘ ber, or in the bowl under, or behind any
‘ pieces of broken clay which lay most con-
‘ venient for the purpose.’

In this chapter I have given a succinct
view of the sagacity, dexterity, and architec-
tonic powers, exhibited in the construction of
habitations by the different classes of animals.
But I am not without apprehensions, that, in
my endeavours to avoid prolixity, I may have,
in

in some instances, degenerated into obscurity. Enough, however, I hope, has been said, either for the purposes of admiration or of reasoning; and, therefore, I shall not anticipate the reflections of my readers, but proceed to the next subject.

CHAP.

CHAPTER XIV.

Of the Hostilities of Animals.

I N contemplating the system of animation exhibited in this planet, the only one of which we have any extensive knowledge, the mind is struck, and even confounded, with the general scene of havock and devastation which is perpetually, and every where, presented to our view. There is not, perhaps, a single species of animated beings, whose existence depends not, more or less, upon the death and destruction of others. Every animal, when not prematurely deprived of life by those who are hostile to it, or by accident, enjoys a temporary existence, the duration of which is longer or shorter according to its nature, and the rank it holds in the creation; and this existence universally terminates in death and dissolution. This is an established law of Nature, to which every animal is obliged to submit. But this necessary and universal deprivation of individual life,

life, though great, is nothing when compared to the havock occasioned by another law, which impels animals to kill and devour different species, and sometimes their own. In the system of Nature, death and dissolution seem to be indispensable for the support and continuation of animal life.

But, though almost every animal, in some measure, depends for its existence on the destruction of others, there are some species in all the different tribes or classes, which are distinguished by the appellation of *carnivorous* or *rapacious*, because they live chiefly, or entirely on animal food. In the prosecution of this subject, therefore, we shall, in the *first* place, mention some examples of animal hostility and rapacity; and, in the *next* place, endeavour to point out such advantages as result from this apparently cruel institution of Nature. On the last branch of the subject, however, the reader must not expect to have every difficulty removed, and every question solved. Like all the other parts of the oeconomy of Nature, the necessity, or even the seeming cruelty and injustice, of allowing animals to prey upon one another, is a mystery which we can never

ver be enabled completely to unravel. But we are not entirely without hopes of showing several important utilities which result from this almost universal scene of animal devastation.

Of all rapacious animals, *Man* is the most universal destroyer. The destruction of carnivorous quadrupeds, birds, and insects, is, in general, limited to particular kinds. But the rapacity of man has hardly any limitation. His empire over the other animals which inhabit this globe is almost universal. He accordingly employs his power, and subdues or devours every species. Of some of the quadruped tribes, as the horse, the dog, the cat, he makes domestic slaves; and, though in this country, none of these species is used for food, he either obliges them to labour for him, or keep them as sources of pleasure and amusement. From other quadrupeds, as the ox, the sheep, the goat, and the deer kind, he derives innumerable advantages. The ox-kind, in particular, after receiving the emoluments of their labour and fertility, he rewards with death, and then feeds upon their carcases. Many other species, though not commonly
used

used as food, are daily massacred in millions for the purposes of commerce, luxury, and caprice. Myriads of quadrupeds are annually destroyed for the sake of their furs, their hides, their tusks, their odoriferous secretions, &c.

Over the feathered tribes the dominion of man is not less extensive. There is not a single species in the numerous and diversified class of birds, which he either does not, or may not, employ for the nourishment of his body. By his sagacity and address he has been enabled to domesticate many of the more prolific and delicious species, as turkies, geese, and the various kinds of poultry. These he multiplies without end, and devours at pleasure.

Neither do the inhabitants of the waters escape the rapacity of man. Rivers, lakes, and even the ocean itself, feel the power of his empire, and are forced to supply him with provisions. Neither air nor water can defend against the ingenuity, the art, and the destructive industry of the human species. Man may be said even to have domesticated some fishes. In artificial ponds, he feeds and rears carp, tench, perch, trout, and

and other species, and with them occasionally furnishes his table.

It might have been expected, that insects and reptiles, some of which have a most disgusting aspect, would not have excited the human appetite. But we learn from experience, that, in every region of the earth, many insects which inhabit both the earth and the waters, are esteemed as delicate articles of luxury. Even the viper, though its venom be deleterious, escapes not the all-devouring jaws of man.

Thus man holds, and too often exercises, a tyrannical dominion over almost the whole brute creation, not because he is the strongest of all animals, but because his intellect, though of a similar nature, is vastly superior to that of the most sagacious of the less favoured tribes. He reigns over the other animals, because, like them, he is not only endowed with sentiment, but because the powers of his mind are more extensive. He overcomes force by ingenuity, and swiftness by art and persevering industry. But the empire of man over the brute creation is not absolute. Some species elude his power by the rapidity of their flight, by the

the swiftness of their course, by the obscurity of their retreats, and by the element in which they live. Others escape him by the minuteness of their bodies; and, instead of acknowledging their sovereign, others boldly attack him with open hostility. He is also insulted and injured by the stings of insects, and by the poisonous bites of serpents. In other respects, man's empire, though comparatively great, is very much limited. He has no influence on the universe, on the motions and affections of the heavenly bodies, or on the revolutions of the globe which he inhabits. Neither has he a general dominion over animals, vegetables, or minerals. His power reaches not species, but is confined to individuals. Every order of being moves on in its course, perishes, or is renewed, by the irresistible power of Nature. Even man himself, hurried along by the general torrent of time and of Nature, cannot prolong his existence. He is obliged to submit to the universal law; and, like all other organized beings, he is born, grows to maturity, and dies. Though man has been enabled to subdue the animal creation by the superior powers

powers of his mind, his empire, like all other empires, could not be firmly established previous to the institution of pretty numerous societies. Almost the whole of his power is derived from society. It matures his reason, gives exertion to his genius, and unites his forces. Before the formation of large societies, man was perhaps the most helpless and the least formidable of all animals. Naked, and destitute of arms, to him the earth was only an immense desert peopled with strong and rapacious monsters, by whom he was often devoured. Even long after this period, history informs us, that the first heroes were destroyers of wild beasts. But, after the human species had multiplied, and spread over the earth, and when, by means of society and the arts, man was enabled to conquer a considerable part of the globe, he forced the wild beasts gradually to retire to the deserts. He cleared the earth of those gigantic animals who, perhaps, now no longer exist, but whose enormous bones are still found in different regions, and are preserved in the cabinets of the curious. He reduced the numbers of the voracious and noxious species. He
opposed

opposed the powers and the dexterity of one animal to those of another. Some he subdued by address, and others by force. In this manner he, in process of time, acquired to himself perfect security, and established an empire that has no other limits than inaccessible solitudes, burning sands, frozen mountains, or obscure caverns, which are occupied as retreats by a few species of ferocious animals.

Next to *man*, the carnivorous *quadrupeds* are the most numerous and the most destructive. Different parts of the earth are infested with lions, tigers, panthers, ounces, leopards, jaguars, cougars, lynxes, wild cats, dogs, jackals, wolves, foxes, hyaenas, civets, genets, polecats, martins, ferrets, ermines, gluttons, bats, &c. Though all these, and many other tribes of quadrupeds, live solely upon blood and carnage, yet some of them, as the tiger, the wolf, the hyaena, and many other inferior species, are much more rapacious and destructive than others. The lion, though surrounded with prey, kills no more than he is able to consume. But the tiger is grossly ferocious, and cruel without necessity. Though satiated with carnage, he perpetually

petually thirsts for blood. His restless fury has no intervals, except when he is obliged to lie in ambush for prey at the sides of lakes or rivers, to which other animals resort for drink. He seizes and tears in pieces a fresh animal with equal rage as he exerted in devouring the first. He desolates every country that he inhabits, and dreads neither the aspect nor the arms of man. He sacrifices whole flocks of domestic animals, and all the wild beasts which come within the reach of his terrible claws. He attacks the young of the elephant and rhinoceros, and sometimes even ventures to brave the lion. His predominant instinct is a perpetual rage, a blind and undistinguishing ferocity, which often impel him to devour his own young, and to tear their mother in pieces when she attempts to defend them. He delights in blood, and gluts himself with it till he is intoxicated. He tears the body for no other purpose than to plunge his head into it, and to drink large draughts of blood, the sources of which are generally exhausted before his thirst is appeased. The tiger is perhaps the only animal whose ferocity is unconquerable. Neither violence, restraint,

strait, nor bribery, have any effect in softening his temper. With harsh or gentle treatment he is equally irritated. The mild and conciliating influence of society makes no impression on the obduracy and incorrigibleness of his disposition. Time, instead of softening the ferociousness of his nature, only exasperates his rage. He tears, with equal wrath, the hand which feeds him, as that which is raised to strike him. He roars and grins at the sight of every living being. Every animated object he regards as a fresh prey, which he devours before hand with the avidity of his eyes, menaces it with frightful groans, and often springs at it, without regarding his chains, which only restrain, but cannot calm his fury.

In temperate climates, the wolf seems to exceed all other animals in the ferocity and rapaciousness of his disposition. When pressed with hunger, he braves every danger. He attacks all those animals which are under the protection of man, especially such as he can carry off with ease, as lambs, kids, and the smaller kinds of dogs. When successful in his expeditions, he returns often to the charge, till, after being chased and

VOL. II. O wounded

wounded by men and dogs, he retires, during the day, to his den. In the night he again issues forth, traverses the country, roams round the cottages, kills all the animals which have been left without, digs the earth under the doors, enters with a terrible ferocity, and puts every living creature to death, before he chooses to depart, and carry off his prey. When these inroads happen to be fruitless, he returns to the woods, searches about with avidity, follows the track and the scent of wild beasts, and pursues them till they fall a prey to his rapacity. In a word, when his hunger is extreme, he loses all idea of fear, attacks women and children, and sometimes men; at last he becomes perfectly furious by excessive exertions, and generally falls a sacrifice to pure rage and distraction. When several wolves appear together, it is not an association of peace, but of war. It is attended with tumult and dreadful growlings, and indicates an attack upon some of the larger animals, as a stag, an ox, or a formidable mastive. This predatory expedition is no sooner ended than they separate, and every individual returns in silence to his solitude. Wolves are fond
of

of human flesh. They have been known to follow armies, to come in troops to the field of battle, where bodies are carelessly interred, to tear them up, and to devour them with an insatiable avidity: And, when once accustomed to human flesh, these wolves ever after attack men, prefer the shepherd to the flock, devour women, and carry off children. Whole countries are sometimes obliged to arm, in order to destroy the wolves. It is a fortunate circumstance that these dangerous and destructive animals have been long totally extirpated from Great Britain and her islands.

Neither are the *feathered tribes* exempted from the general law of devastation. But the number of birds of prey, properly so called, is much less in proportion than that of carnivorous quadrupeds. Birds of prey are likewise weaker; and, of course, the destruction of animal life they occasion is much more limited than the immense devastations daily committed by rapacious quadrupeds. But, as if tyranny never lost sight of its rights, great numbers of birds make prodigious depredations upon the inhabitants of the waters. A vast tribe of

O 2

birds

birds frequent the waters, and live solely upon fishes. In a certain sense, every species of bird may be said to be a bird of prey; for almost the whole of them devour flies, worms, and other insects, either for food to themselves or their young. Birds of prey, like carnivorous quadrupeds, are not so prolific as the milder and more inoffensive kinds. Most of them lay only a small number of eggs. The great eagle and the osprey produce only two eggs in a season. The pigeon, it may be said, lays no more. But it should be considered that the pigeon produces two eggs three, four, or five times, from spring to autumn. All birds of prey exhibit an obduracy and a ferociousness of disposition, while the other kinds are mild, chearful, and gentle, in their aspect and manners. Most birds of prey expel their offspring from the nest, and relinquish them to their fate, before they are sufficiently able to provide for themselves. This cruelty is the effect of personal want in the mother. When prey is scanty, which often happens, she in a manner starves herself to support her young. But, when her hunger becomes excessive, she forgets her parental affection, strikes, expels, and sometimes, in a paroxysm of fury produced by want, kills her offspring.

offspring. An aversion to society is another effect of this natural and acquired obduracy of temper. Birds of prey, as well as carnivorous quadrupeds, never associate. Like robbers, they lead a solitary and wandering life. Mutual attachment unites the male and the female; and, as they are both capable of providing for themselves, and can give mutual assistance in making war against other animals, they never separate, even after the season of love. The same pair are uniformly found in the same place; but they never assemble in flocks, nor even associate in families. The larger kinds, as the eagles, require a greater quantity of food, and, for that reason, never allow their own offspring, after they have become rivals, to approach the places which the parents frequent. But all those birds, and all those quadrupeds, which are nourished by the productions of the earth, live in families, are fond of society, and assemble in numerous flocks, without quarrelling or disturbing one another.

Both the earth and the air furnish examples of rapacious animals. In these elements, however, the number of carnivorous animals is comparatively small. But every inhabitant

inhabitant of the *waters* depends for its existence upon rapine and destruction. The life of every *fish*, from the smallest to the greatest, is one continued scene of hostility, violence, and evasion. Their appetite for food is almost insatiable. It impels them to encounter every danger. They are in continual motion; and the object of all their movements is to devour other fishes, or to avoid their own destruction. Their desire for food is so keen and undistinguishing, that they greedily swallow every thing which has the appearance of animation. Those that have small mouths feed upon worms and the spawn of other fishes; and those whose mouths are larger devour every animal, their own species not excepted, that can pass through their gullet. To avoid destruction, the smaller fry retire to the shallows, where the larger kinds are unable to pursue them. But, in the watery element, no situation is absolutely safe; for, even in the shallows, the oyster, the scallop, and the muscle, lie in ambush at the bottom, with their shells open, and, when a small fish comes into contact with them, they instantly close their shells upon him, and devour

at

at leisure their imprisoned prey. Neither is the hunting or pursuit of fishes confined to particular regions. Shoals of one species follow, with unwearied ardour, those of another through vast tracts of the ocean. The cod pursues the whiting from the banks of Newfoundland to the southern coasts of Spain.

It is a remarkable circumstance in the history of animated Nature, that carnivorous birds and quadrupeds are less prolific than the inoffensive and associating kinds; but, on the contrary, that the inhabitants of the waters, who are all carnivorous, are endowed with a most astonishing fecundity. All kinds of fishes, a few only excepted, are oviparous. Notwithstanding the amazing destruction of their eggs by the smaller fry that frequent the shores, by aquatic birds, and by the larger fishes, the numbers which escape are sufficient to supply the ocean with inhabitants, and to afford nourishment to a very great portion of the human race. A cod, for instance, according to the accurate computation of Lewenhoeck, produces, from one roe, above nine millions of eggs in a single season. The flounder lays annually above one million, and the mackarel more than five hundred thousand: An increase so great, if permitted

mitted to arrive at maturity, that the ocean itself, in a few centuries, would not be spacious enough to contain its animated productions. This wonderful fertility answers two valuable purposes. In the midst of numberless enemies it continues the respective species, and furnishes to all a proper quantity of nourishment.

We have thus seen that man, some quadrupeds, some birds, and all fishes, are carnivorous animals. But this system of carnage descends still lower. Many of the *insect* tribes derive their nourishment from putrid carcasses, from the bodies of living animals, or from killing and devouring weaker species. How many flies are daily sacrificed by spiders, a most voracious and a most numerous tribe of insects? In return, spiders are greedily devoured by flies, which are distinguished by the name of *ichneumons*. The number of these ichneumon flies is inconceivable; and, if it were not for the prodigious havock they make upon caterpillars and other insects, the fruits of the earth would be entirely destroyed. Wasps are extremely fond of animal food. They frequent butchers stalls, and beat off the flesh fly, and every other insect that resorts thither for the purpose

purpose of depositing its eggs in the meat. Butchers take the advantage of this jealous warfare. They encourage the wasps, and make centinels of them, by giving them livers, which they prefer to more fibrous flesh, probably because they can cut livers more easily with their teeth.

The libella, dragon, or lady-fly, is well known by the beauty of its colours, and the symmetry of its form. For these external qualities it has received the appellation of *lady-fly*. Its dispositions and its mode of life, however, are more ferocious and warlike than those of the Amazones. Like birds of prey, they hover about in the air, for the sole purpose of devouring almost every species of winged insect. They accordingly frequent marshy grounds, pools of water, and the margins of rivers, where insects most abound. Their appetite is so gross and voracious, that they not only devour small flies, but even the large flesh-fly, moths, and butterflies, of every kind.

It has been often said, that no animal spontaneously feeds upon its own species. This remark has probably been intended as an apology for, or at least a limitation to, the
general

general system of carnage established by Nature. But the observation, whatever might have been its intention, is unhappily a result of ignorance; for some quadrupeds, all fishes, and many insects, make no such discrimination. The weaker are uniformly preyed upon by the stronger. Reaumur put twenty of those caterpillars which feed upon the leaves of the oak into a vial. Though he regularly supplied them with plenty of fresh oak leaves, he observed that the number of dead ones daily increased. Upon a more attentive examination into the cause of this mortality, he found, that the stronger attacked with their teeth, killed, sucked out the vitals of their weaker companions, and left nothing but the head, feet, and empty skins. In a few days, one only of the twenty remained in life.

Caterpillars have myriads of external enemies, as birds of almost every kind, many of the smaller quadrupeds, their own species, and numberless insects. But this vast source of devastation is still augmented by what may be denominated their internal enemies. Many flies deposit their eggs in the bodies of caterpillars. From these eggs proceed small maggots, which gradually devour the vitals of the
the

the animal in which they reside. When about to be transformed into chrysalids, they pierce the skin of the caterpillar, spin their pods and remain on the empty skin till they assume the form of flies, and escape into the air to perform the same cruel office to another unfortunate reptile. Every person must recollect to have seen the colewort or cabbage caterpillar stuck upon old walls, or the windows of country cottages, totally covered with these chrysalids, which have the form of small maggots, and are of a fine yellow colour. One of the most formidable enemies of the caterpillar is a black worm, with six crustaceous legs. It is as long, and thicker than an ordinary sized caterpillar. In the fore part of the head it has two curved pincers, with which it quickly pierces the belly of a caterpillar, and never quits the prey till it is entirely devoured. The largest caterpillar is not sufficient to nourish this worm for a single day; for it daily kills and eats several of them. These gluttonous worms, when gorged with food, become inactive, and almost motionless. When in this satiated condition, young worms of the same species attack and devour them. Of all trees, the oak, perhaps, nourishes

nourishes the greatest number of different caterpillars, as well as of different insects. Amongst others, the oak is inhabited by a large and beautiful beetle. This beetle frequents the oak, probably because that tree is inhabited by the greatest number of caterpillars. It marches from branch to branch; and, when disposed for food, attacks and devours the first caterpillar that comes in its way.

The pucerons, vine-fretters, or plant-lice, are very injurious to trees and vegetables of almost every kind. Their species are so numerous, and all of them are endowed with such a wonderful fertility, that we should expect to see the leaves, the branches, and the stems of every plant totally covered with them. But this astonishing fecundity, and the devastation these small insects would unavoidably produce among the vegetable tribes, is checked by numberless enemies. Myriads of insects of different classes, of different genera, and of different species, seem to be produced for no other purpose but to devour the pucerons. Some of these insects are so voracious, that, notwithstanding the extreme prolific powers of the pucerons, we have reason

son to be surpris'd that their species are not entirely annihilated. On every leaf inhabited by the puceron we find worms of different kinds. These worms feed not upon the leaves, but upon the pucerons, whom they devour with an almost incredible rapacity. Some of these worms are transformed into flies with two wings, others into flies with four wings, and others into beetles. While in the worm state, one of these gluttonous insects will suck out the vitals of twenty pucerons in a quarter of an hour. Reaumur supplied a single worm with more than a hundred pucerons, every one of which it devoured in less than three hours.

Beside the general system of carnage produced by the necessity of one animal's feeding upon another, there are other sources of destruction, which originate from very different motives. Man is not the only animal who wages war with his own species. War among mankind, in certain accidental situations of society, may be productive, to particular nations or communities, of beneficial effects. But every advantage deriv'd by war to one nation is acquired at the expence, and either the partial or the total ruin of another. If universal
peace

peace could be completely established, and if the earth were cultivated to the highest perfection, it is not probable that the multiplication of the human species would ever rise to such a degree as to exceed the quantity of provisions produced by agriculture, and by the breeding of domestic animals, necessary for their existence and happiness. But, as long as men are actuated by ambition, by resentment, and by many other hostile passions, war and animosity, with all their train of bloodshed and calamity, will for ever continue to harass and persecute the human kind. Let us, however, be humble. We cannot unfold the mysteries of Nature; but we may admire her operations, and submit, with a becoming resignation, to her irresistible decrees. The man, if such a man there be, whose strength of mind enables him to observe steadfastly this conduct, is the only real philosopher.

As formerly remarked, man is not the only animal that makes war with his own species. Quadrupeds, birds, fishes, insects, independently of their appetite for food, occasionally fight and kill each other. On this subject we shall confine ourselves to a few examples derived from the insect tribes.

A society

A society or hive of bees consists of a female, of males, and of drones, or neuters. These three kinds continue, for some time, in the most perfect harmony, and mutually protect and assist each other. The neuters, or working bees, discover the strongest attachment and affection to the males, even when in their worm state. The neuters are armed with a deadly sting, of which the males are destitute. Both are equally produced by the same mother, and live in the same family. But, notwithstanding their temporary affection, there are times when the neuters cruelly massacre the males. Among the laws of polished republics, we find some which are extremely barbarous. The Lacedemonians were allowed to kill such of their children as were produced in a defective or maimed state, because they would become a burden upon the community. The laws of the Chinese permit actions equally inhuman. We perhaps know not all the reasons why the neuter bees treat the males with so much cruelty. There is a time, however, when the males become perfectly useless to the community; and it is not incurious to remark, that the general massacre never commences till this period arrives.

Whenever

Whenever a stranger bee enters a hive, his temerity is uniformly punished with death. But mortal combats are not unfrequent between bees belonging to the same hive. These combats are most frequent in clear and warm weather. Sometimes two combatants come out of the hive closely fastened to each other. At other times the attack is made in the air. But, in whatever way the battle begins, both combatants uniformly come to the ground before it is terminated by the death of one of the parties. When they reach the ground, each individual, like a wrestler, endeavours to gain the most advantageous position for stinging his adversary to death. Sometimes, though rarely, the sting is left in the wound. If this were generally the case, every combat would prove fatal to two bees; for the victor could not long survive the loss of his sting. These battles sometimes continue near an hour before one of the flies is left expiring on the ground.

Beside these single combats, general actions are not unfrequent, especially in the swarming season. When two swarms, or colonies, happen to contend for the same habitation, a general and bloody engagement immediately ensues. These engagements often continue
for

for hours, and never terminate without great havock on both sides. The sting is not the only weapon employed in war by bees. They are furnished with two strong fangs or teeth, with which they cruelly tear each other. Even in general engagements, all the combats are single. But, when the great slaughter of the males is committing, three or four neuters are not ashamed to attack a single fly.

Every wasp's nest, about the beginning of October, exhibits a singular and a cruel scene. At this season, the wasps cease to bring nourishment to their young. From affectionate mothers or nurses, they at once become barbarous step-mothers. They are worse; for they drag the young worms from their cells, and carry them out of the nest. Being thus exposed to the weather, and deprived of nourishment, every one of them unavoidably perishes. This devastation is not, like that of the honey-bees, confined to the male-worms. Here no worm, of whatever denomination or sex, escapes the general and undistinguishing massacre. Beside exposing the worms to the weather, the wasps kill them with their

VOL. II. P fangs.

fangs. This fact seems to be a violation of parental affection, one of the strongest principles in animal nature. But the intentions of Nature, though they may often elude our researches, are never wrong. What appears to us cruel and unnatural in this instinctive devastation committed annually by the wasps, is perhaps an act of the greatest mercy and compassion. Wasps are not, like the honey-bees, endowed with the instinct of laying up a store of provisions for winter subsistence. If not prematurely destroyed by their parents, the young must necessarily die a more cruel and lingering death, occasioned by hunger. Hence this seemingly harsh conduct in the oeconomy of wasps, instead of affording an exception to the universal benevolence and wisdom of Nature, is, in reality, a merciful institution. Besides, as the multiplication of wasps is prodigious, and as they are a noxious race both to man and other animals, and especially to many tribes of insects, if their increase were not checked by such a dreadful carnage, their depredations, in a few years, would annihilate other species, break the chain of Nature, and even prove destructive to man and the larger animals.

The

The same instinctive slaughter, and probably for the same reasons, is made by the hornets. Towards the end of October, all the worms and nymphs are dragged out of the nest and killed. The neuters and males fall daily victims to the cold; so that, at the end of winter, a few fertile females only remain to continue the species.

According to the adopted plan, we shall finish this subject with some observations which may have a tendency to reconcile our minds to a system so destructive to individuals of every species, that humanity, when not enlightened by a ray of philosophy, is apt to revolt, and to brand Nature with cruelty and oppression. Nature, it must be confessed, seems almost indifferent to individuals, who perish every moment in millions, without any apparent compunction. But, with regard to species of every description, her uniform and uninterrupted attention to the preservation and continuation of the great system of animation is conspicuous, and merits admiration. Life, it should appear, cannot be supported without the intervention of death. Through almost the whole of animated Nature, as we have seen, nothing but rapine,

and the destruction of individuals, prevail. This destruction, however, has its use. Every animal, after death, administers life and happiness to a number of others. In many animals, the powers of digestion, and of assimilation, are confined to animal substances alone. If deprived of animal food, such species, it is evident, could not exist. The chief force of this observation, it is admitted, is applicable solely to the carnivorous tribes, strictly so denominated. But, from the facts formerly enumerated, and from the daily experience of every man, it is apparent, that, perhaps, no animal does or can exist totally independent of food that is or has been animated. Sheep, oxen, and all herbivorous animals, though not from choice, and even without consciousness, daily devour thousands of insects. This may be one reason why cattle of all kinds fatten so remarkably in rich pastures; for insects are always most numerous where the herbage is luxuriant. Nature is so profuse in her animated productions, that no food can be eat, and no fluid can be drunk, in which animal substances, either in a living or dead state, are not to be found.

To this reasoning it may be objected, Why has Nature established a system so cruel?

Why

Why did she render it necessary that one animal could not live without the destruction of another? To such questions no answer can be either given or expected. No being, except the Supreme, can unfold this mystery. Perhaps it even exceeds the limits of possibility to establish such an extended system of animation upon any other foundation. From the general benevolence of the great Creator, we are warranted to conclude that this is really the case. But it is fruitless to dwell upon subjects which are inscrutable, and far removed beyond the powers of human intellect. We shall therefore descend, and endeavour to point out some advantages which result from this mysterious institution of Nature.

On this branch of the subject, the reader will easily perceive that much order or connection is not to be expected.

The hostilities of animals, mankind not excepted, give rise to mutual improvement. Animals improve, and discover a superiority of parts, in proportion to the number of enemies they have to attack or evade. The weak, and consequently timid, are obliged to exert their utmost powers in inventing and practising

practising every possible mode of escape. Pure instinct powerfully prompts ; but much is learned by experience and observation. Rapacious animals, on the contrary, by frequent disappointment, are obliged to provide against the cunning and alertness of their prey. Herbivorous animals, as they have little difficulty in procuring food, are proportionally stupid ; but they would be still more stupid, if they had no enemies to annoy them. Man, if his attention and talents were not excited by the animosities of his own species, by the attacks of ferocious animals, and even by those of the insect tribes, would be an indolent, an incurious, a dirty, and an ignorant animal. Those of the human race, accordingly, who procure their food with little or no industry, as we learn from a multitude of travellers and voyagers, are perfectly indolent and brutishly stupid. Timid animals never use the arts of defence, or provide against danger, except from three causes, pure instinct, which is implanted in their natures, imitation, and experience. By experience, timid animals are taught the arts of evasion. Flight is instinctive ; but the modifications of it are acquired by imitation and experience.

Hostilities,

Hostilities, in some instances, seem to arise, not from a natural antipathy of one species to another, but from a scarcity of food. The celebrated Captain Cooke informs us, that, in Staten Island, birds of prey assemble promiscuously with penguins and other birds, without the one offering any injury, or the other discovering the smallest symptom of terror. In that island, the rapacious birds, perhaps, find plenty of food from dead seals, sea-lions, and fishes.

A profusion of animal life seems to be the general intention of Nature. For this purpose, when not modified or restrained by the industry and intelligence of man, she uniformly covers the surface of the earth with trees and vegetables of every kind, which supply myriads of animated beings with food. But the greatest possible extension of life would still be wanting, if animals did not prey upon each other. If all animals were to live upon vegetables alone, many species, and millions of individuals, which now enjoy life and happiness, could have no existence; for the productions of the earth would not be sufficient to support them. But, by making animals feed upon each other, the system of animation

animation and of happiness is extended to the greatest possible degree. In this view, Nature, instead of being cruel and oppressive, is highly generous and beneficent.

To diminish the number of noxious animals, and to augment that of useful vegetables, has been the uniform scope of human industry. A few species of animals only are of immediate utility to man. These he either cultivates with care, or hunts for his prey. The ox, the sheep, the goat, and other animals which are under his peculiar protection, he daily uses for food. This is not cruelty. He has a right to eat them: For, like Nature, though he occasionally destroys domestic animals, a timid and docile race of beings, by his culture and protection he gives life and happiness to millions, which, without his aid, could have no existence. The number of individuals among animals of this description, if they were not cherished and defended by man, would be extremely limited; for, by the mildness of their dispositions, the comparative weakness of their arms, and the universal and strong appetite for them by rapacious quadrupeds and

and birds of prey, though the species might, perhaps, be continued, the number of individuals would, of necessity, be very small.

There is a wonderful balance in the system of animal destruction. If the general profusion of the animated productions of Nature had no other check than the various periods to which their lives, when not extinguished by hostilities of one kind or another, are limited, the whole would soon be annihilated by an universal famine, and the earth, instead of every where teeming with animals, would, unless re-peopled by a new creation, exhibit nothing but a mute, a lifeless, and an inactive scene. If even a single species were permitted to multiply without disturbance, the food of other species would be exhausted, and, of course, a period would be put to their existence. The herbivorous and frugivorous races, if not restrained by the carnivorous, would soon increase to a hurtful degree. Carnivorous animals are the barriers fixed by Nature to noxious inundations of other kinds. The carnivorous tribes may be compared to the hoe and the pruning hook, which, by diminishing
the

the number of plants when too close, or lopping off their luxuriances, make the others grow to greater perfection. To those swarms of insects which cover the surface of the earth, are opposed an army of birds, an active, a vigilant, and a voracious race. Hares, rabbits, mice, rats, are exposed to the depredations of carnivorous quadrupeds and birds. The larger cattle, as the ox, the deer, the sheep, &c. are not exempted from enemies: And man, by the superiority of his mental powers, checks the multiplication of the carnivorous tribes, and maintains the balance and empire of the animal system. Those species which are endowed with uncommon fertility have the greatest number of enemies. The caterpillar, the puceron, and insects in general, one of the most prolific tribes of animals, are attacked and devoured by numerous hostile bands. No species, however, is ever exhausted. The balance between gain and loss is perpetually preserved. The earth, the seas, the atmosphere, may be considered as an immense and variegated pasture. In this view, it is most judiciously cultivated and stocked by the numerous animated beings which it is destined to support. Every animal and every vegetable furnish

nish subsistence to particular species. Thus, nothing of value is lost; and every species is abundantly supplied with food.

That the general balace of animation is constantly preserved, we learn from daily experience. The reader, however, I presume, will not be displeased to have some examples of the modes employed by Nature to accomplish this effect suggested to him.

After an inundation of the Nile, the lower parts of Egypt are greatly infested with serpents, frogs, mice, and other vermin. At that period, the storks resort thither in immense multitudes, and devour the serpents, frogs and mice, which, without this dreadful carnage, would be highly noxious to the inhabitants. Belon, a most ingenious and faithful French naturalist, remarks, that, in many places, the land could not be inhabited, if the storks did not destroy the amazing numbers of mice which frequently appear in Palestine, and other parts of the East bordering upon Egypt. The Egyptian vulture, says Hasselquist, is of singular benefit to that country. It eats up all the dung and off-falls in the towns, and the carcases of camels, horses, asses, &c. in the fields, which, if not quickly devoured, would,

would, in that warm climate, by their putref-
cency, be productive of disease and death to
the inhabitants. Putrid carcases, in all coun-
tries, are both offensive to the nostrils and
hurtful to health. But Nature, by various
instruments, soon removes the evil. An ani-
mal no sooner dies, than, in a very short
time, he is consumed by bears, wolves, foxes,
dogs, and ravens. In situations where these
animals dare not approach, as in the vicinity
of towns and villages, a dead horse, in a few
days, is devoured by myriads of maggots. In
the uncultivated parts of America, serpents
and snakes of different kinds abound. Af-
ter it was discovered that swine greedily de-
voured serpents, hogs were uniformly kept
by all new settlers. Caterpillars are destruc-
tive to the leaves and fruits of plants. Their
numbers and varieties are immense. But
their devastations are checked by many ene-
mies. Without a profusion of caterpillars,
most of the smaller birds, especially when
young, could not be supported. By devour-
ing the caterpillars, these birds preserve the
fruits of the earth from total destruction. Mr.
Bradley, in his general treatise of husbandry
and gardening, has published a letter, in which
the

the author opposes the common opinion, that birds, and particularly sparrows, do much mischief in our gardens and fields. The fact is admitted. But the great utility of these birds is overlooked: For this author proves, that they are much more useful than noxious. He shows, that a pair of sparrows, during the time they have their young to feed, destroy, every week, 3360 caterpillars. This calculation he founded upon actual observation. He discovered that the two parents carried to the nest 40 caterpillars in an hour. He then supposes, which is a moderate supposition, that the sparrows enter the nest only 12 hours each day, which is a daily consumption of 480 caterpillars. This sum, multiplied by 7, or the days of a week, gives 3360 caterpillars extirpated weekly from a garden. The utility of these birds is not limited to this circumstance alone; for they likewise feed their young with butterflies, and other winged insects, each of which, if not destroyed in this manner, would be the parent of several hundreds of caterpillars. Those butterflies and caterpillars which are covered with hair are rejected by some birds, who prefer flies
of

of a smother and smaller kind. But these hairy species, it should be considered, are the food of the worms which are transformed into those smaller flies that afford nourishment to the birds which reject the hairy caterpillars and butterflies.

Shell-fishes are extremely prolific, and so strongly fortified by Nature, that their increase, one should imagine, would soon augment to a degree that might be hurtful to other species. Their noxious multiplication, however, is checked by numberless enemies. But their most destructive enemy is the trochus, which is a kind of sea-snail. This animal is furnished with a strong, muscular, hollow trunk, bordered at the extremity with a cartilage toothed like a saw. Against this instrument, which acts like an augre, no shell, however hard or thick, is a sufficient defence. These animals, called *trochi*, fix themselves upon an oyster or a muscle, bore through the shell with their trunk, and devour their prey at their leisure. The animal attacked, if a bivalve, may open or shut its shell; but no efforts of this kind can be of any avail; for the trochus remains immoveably fixed till it has completely sucked out the vitals of its prey. In this
cruel

cruel occupation the trochus often continues for days, and even weeks, before the life of the animal attacked is fully extinguished. The operation of the trochus may be seen in the shells of many oysters, muscles, and other shell-fishes; for their shells are often pierced with a number of circular holes.

The amazing size and strength of the whale, one should imagine, would secure it from the insults of every other animal. But, beside the annual depredations made by man upon the cetaceous tribes, they are often attacked and killed by the sword-fish. The snout of this comparatively small animal is armed with a long, hard, projection of bone, each edge of which is furnished with a number of strong, flat, and sharp points, or teeth, some of which, especially near the snout, are an inch and a half in length. With this instrument the sword-fish boldly attacks the whale. I have often had the pleasure, says Pere Labat*, of seeing their combats. The whale has no other defence but its tail, with which it endeavours to strike its antagonist. But, as the sword-fish

* Nouv. Voyage, tom. 6. page 150.

is more active and nimble than the whale, he easily parries the blow by springing into the air, and renewing the attack with his saw-like instrument. Whenever he succeeds, the sea is dyed red with the blood issuing from the wound. The fury of the whale appears from the vehemence with which it lashes the waters, each stroke resounding like the report of a cannon.

Many small birds, and particularly the wren and the tit-mouse, may be seen during the winter-season, pecking at the buds and branches of trees in our gardens. To these little animals Nature has entrusted the charge of preventing the noxious multiplication of those worms which feed upon fruits. Nature, as far as we are able to trace her operations, does nothing in vain, or without some valuable intention. No animals exist which are not useful, either by affording nourishment to, or preventing the hurtful increase of other species.

Upon the whole, every animated being that inhabits this globe seems to be destined by Nature, not for its own individual existence and happiness alone, but likewise for the existence and happiness of other animated beings.

beings. A circle of animation and of destruction goes perpetually round. This is the oeconomy of Nature. Different species of animals live by the mutual destruction of each other. Even among individual men, the strong too often oppresses the weak; but, on the other hand, the wise instruct the ignorant. These are the bonds of society, and the sources of improvement.

CHAPTER XV.

Of the Artifices of Animals.

IT will be recollected, that many instances of the dexterity and artifices employed by different animals in various parts of their manners and oeconomy, have been occasionally mentioned in several of the foregoing chapters. This circumstance, to avoid repetitions, will necessarily render the present chapter proportionally short.

The artifices practised by animals proceed from several motives, many of which are purely instinctive, and others are acquired by experience and imitation. Their arts, in general, are called forth and exerted by three great and important causes, the love of life, the desire of multiplying and continuing the species, and that strong attachment which every animal has to its offspring. These are the sources from which all the movements, all the dexterity, and all the sagacity of animals originate. The principle of self-preservation
is

is instinctive, and strongly impressed upon the minds of all animated beings. It gives rise to innumerable arts of attack and defence, and not unfrequently to surprising exertions of sagacity and genius. The same remark is applicable to the desire of multiplication, and to parental affection. Upon this subject we shall, as usual, give some examples of animal artifice, which may both amuse and inform some readers.

When a bear, or other rapacious animal, attacks cattle, they instantly join and form a phalanx for mutual defence. In the same circumstances, horses rank up in lines, and beat off the enemy with their heels. Pontopidon tells us, that the small Norwegian horses, when attacked by bears, instead of striking with their hind-legs, rear, and, by quick and repeated strokes with their fore-feet, either kill the enemy, or oblige him to retire. This curious, and generally successful defence, is frequently performed in the woods, while a traveller is sitting on the horse's back. It has often been remarked, that troops of wild horses, when sleeping either in plains or in the forest, have always one of their number awake, who acts

as a centinel, and gives notice of any approaching danger.

Margraaf informs us, that the monkeys in Brazil, while they are sleeping on the trees, have uniformly a centinel to warn them of the approach of the tiger or other rapacious animals; and that, if ever this centinel is found sleeping, his companions instantly tear him in pieces for his neglect of duty. For the same purpose, when a troop of monkeys are committing depredations on the fruits of a garden, a centinel is placed on an eminence, who, when any person appears, makes a certain chattering noise, which the rest understand to be a signal for retreat, and immediately fly off and make their escape.

The deer-kind are remarkable for the arts they employ in order to deceive the dogs. With this view the stag often returns twice or thrice upon his former steps. He endeavours to raise hinds or younger stags to follow him, and to draw off the dogs from the immediate object of their pursuit. If he succeeds in this attempt, he then flies off with redoubled speed, or springs off at a side, and lies down on his belly to conceal himself. When in this situation, if by any means

means his foot is recovered by the dogs, they pursue him with more advantage, because he is now considerably fatigued. Their ardour increases in proportion to his feebleness; and the scent becomes stronger as he grows warm. From these circumstances the dogs augment their cries and their speed; and, though the stag employs more arts of escape than formerly, as his swiftness is diminished, his doublings and artifices become gradually less effectual. No other resource is now left him but to fly from the earth which he treads, and go into the waters, in order to cut off the scent from the dogs, when the huntsmen again endeavour to put them on the track of his foot. After taking to the water, the stag is so much exhausted that he is incapable of running much farther, and is soon *at bay*, or, in other words, turns and defends himself against the hounds. In this situation he often wounds the dogs, and even the huntsmen, by blows with his horns, till one of them cuts his hams to make him fall, and then puts a period to his life. The fallow-deer is more delicate, less savage, and approaches nearer to the domestic state than the stag. The males, during the rutting season,

son, make a bellowing noise, but with a low and interrupted voice. They are not so furious as the stag. They never depart from their own country in quest of females; but they bravely fight for the possession of their mistresses. They associate in herds, which generally keep together. When great numbers are assembled in one park, they commonly form themselves into two distinct troops, which soon become hostile, because they are both ambitious of possessing the same part of the inclosure. Each of these troops has its own chief or leader, who always marches foremost, and he is uniformly the oldest and strongest of the flock. The others follow him; and the whole draw up in order of battle, to force the other troop, who observe the same conduct, from the best pasture. The regularity with which these combats are conducted is singular. They make regular attacks, fight with courage, and never think themselves vanquished by one check; for the battle is daily renewed till the weaker are completely defeated, and obliged to remain in the worst pasture. They love elevated and hilly countries. When hunted, they run not straight out,
like

like the stag, but double, and endeavour to conceal themselves from the dogs by various artifices, and by substituting other animals in their place. When fatigued and heated, however, they take the water, but never attempt to cross such large rivers as the stag. Thus, between the chace of the fallow-deer and of the stag, there is no material difference. Their sagacity and instincts, their shifts and doublings, are the same, only they are more frequently practised by the fallow-deer. As he runs not so far before the dogs, and is less enterprising, he has oftener occasion to change, to substitute another in his place, to double, return upon his former tracks, &c. which renders the hunting of the fallow-deer more subject to inconveniencies than that of the stag.

The roe-deer is inferior to the stag and fallow-deer both in strength and stature; but he is endowed with more gracefulness, courage, and vivacity. His eyes are more brilliant and animated. His limbs are more nimble; his movements are quicker, and he bounds with equal vigour and agility. He is likewise more crafty, conceals himself with greater address, and derives superior resources

sources from his instincts. Though he leaves behind him a stronger scent than the stag, which increases the ardour of the dogs, he knows how to evade their pursuit, by the rapidity with which he commences his flight, and by his numerous doublings. He delays not his arts of defence till his strength begins to fail him ; for he no sooner perceives that the first efforts of a rapid flight have been unsuccessful, than he repeatedly returns upon his former steps ; and, after confounding, by these opposite motions, the direction he has taken, after intermixing the present with the past emanations of his body, he, by a great bound, rises from the earth, and, retiring to a side, lies down flat on his belly. In this immoveable situation, he often allows the whole pack of his deceived enemies to pass very near him. The roe-deer differs from the stag in disposition, manners, and in almost every natural habit. Instead of associating in herds, they live in separate families. The two parents and the young go together, and never mingle with strangers. They are constant in their amours, and never unfaithful like the stag. The females commonly produce two fawns, the one a male and the other a female.

male. These young animals, who are brought up and nourished together, acquire a mutual affection so strong, that they never depart from each other. This attachment is something more than love; for, though always in company, they feel the rut but once a year, and it continues only fifteen days. At this period the father drives off the fawns, as if he intended that they should yield their place to those which are to succeed, in order to form new families for themselves. After the rutting season, however, is past, the fawns return to their mother, and continue with her some time longer; after which they separate for ever, and remove to a distance from the place of their nativity. When about to bring forth, the female separates from the male; and, to avoid the wolf, her most dangerous enemy, conceals herself in the deepest recesses of the forest. In a week or two the fawns are able to follow her. When threatened with danger, she hides them in a close thicket; and so strong is her parental affection, that, in order to preserve her offspring from destruction, she presents herself to be chased.

Hares

Hares possess not, like rabbits, the art of digging retreats in the earth. But they neither want instinct sufficient for their own preservation, nor sagacity for escaping their enemies. They form seats or nests on the surface of the ground, where they watch, with the most vigilant attention, the approach of any danger. In order to deceive, they conceal themselves between clods of the same colour with that of their own hair. When pursued, they first run with rapidity, and then double, or return upon their former steps. From the place of starting, the females run not so far as the males; but they double more frequently. Hares hunted in the place where they were brought forth, seldom remove to a great distance from it, but return to their form; and, when chased two days successively, on the second day they perform the same doublings they had practised the day before. When hares run straight out to a great distance, it is a proof that they are strangers. Male hares, especially during the most remarkable period of rutting, which is in the months of January, February, and March, sometimes perform journies of several miles in quest of mates; but, as soon as they are
started

started by dogs, they fly back to the place of their nativity. 'I have seen a hare,' Fouilloux remarks, 'so sagacious, that, after hearing the hunter's horn, he started from his form, and, though at the distance of a quarter of a league, went to swim in a pool, and lay down on the rushes in the middle of it, without being chased by the dogs. I have seen a hare, after running two hours before the dogs, push another from his seat, and take possession of it. I have seen others swim over two or three ponds, the narrowest of which was eighty paces broad. I have seen others, after a two hours chase, run into a sheep-fold and lie down among them. I have seen others, when hard pushed, run in among a flock of sheep, and would not leave them. I have seen others, after hearing the noise of the hounds, conceal themselves in the earth. I have seen others run up one side of a hedge and return by the other, when there was nothing else between them and the dogs. I have seen others, after running half an hour, mount an old wall, six feet high, and clap down in a hole covered with iyy. Lastly, I have seen others swim over a river,

‘ river of about eighty paces broad, oftener
‘ than twice, in the length of two hundred
‘ paces.’

The fox has, in all ages and nations, been celebrated for craftiness and address. Acute and circumspect, sagacious and prudent, he diversifies his conduct, and always reserves some art for unforeseen accidents. Though nimbler than the wolf, he trusts not entirely to the swiftness of his course. He knows how to ensure safety, by providing himself with an asylum, to which he retires when danger appears. He is not a vagabond, but lives in a settled habitation and in a domestic state. The choice of situation, the art of making and rendering a house commodious, and of concealing the avenues which lead to it, imply a superior degree of sentiment and reflection. The fox possesses these qualities, and employs them with dexterity and advantage. He takes up his abode on the border of a wood, and in the neighbourhood of cottages. Here he listens to the crowing of the cocks and the noise of the poultry. He scents them at a distance. He chooses his time with great judgment and discretion. He conceals both his route and
his

his design. He moves forward with caution, sometimes even trailing his body, and seldom makes a fruitless expedition. When he leaps the wall, or gets in underneath it, he ravages the court-yard, puts all the fowls to death, and then retires quietly with his prey, which he either conceals under the herbage, or carries off to his kennel. In a short time he returns for another, which he carries off and hides in the same manner, but in a different place. In this manner he proceeds, till the light of the sun, or some movements perceived in the house, admonish him that it is time to retire to his den. He does much mischief to the bird-catchers. Early in the morning he visits their nets and their bird-lime, and carries off successively all the birds that happen to be entangled. The young hares he hunts in the plains, seizes old ones in their seats, digs out the rabbits in the warrens, finds out the nests of partridges, quails, &c. seizes the mothers on the eggs, and destroys a prodigious number of game. Dogs of all kinds spontaneously hunt the fox. Though his odour be strong, they often prefer him to the stag or the hare. When pursued he runs to his hole; and

and it is not uncommon to send in terriers to detain him till the hunters remove the earth above, and either kill or seize him alive. The most certain method, however, of destroying a fox is to begin with shutting up the hole, to station a man with a gun near the entrance, and then to search about with the dogs. When they fall in with him, he immediately makes for his hole. But, when he comes up to it, he is met with a discharge from the gun. If the shot misses him, he flies off with full speed, takes a wide circuit. and returns again to the hole, where he is fired upon a second time; but, when he discovers that the entrance is shut, he darts away straight forward, with the intention of never revisiting his former habitation. He is next pursued by the hounds, whom he seldom fails to fatigue; because, with much cunning, he passes through the thickest part of the forest, or places of the most difficult access, where the dogs are hardly able to follow him; and, when he takes to the plains, he runs straight out, without either stopping or doubling. But the most effectual way of destroying foxes is to lay snares baited with live pigeons, fowls,

fowls, &c. The fox is an exceedingly voracious animal. Beside all kinds of flesh and fishes, he devours, with equal avidity, eggs, milk, cheese, fruits, and particularly grapes. He is so extremely fond of honey, that he attacks the nests of wild bees. They at first put him to flight by numberless stings; but he retires for the sole purpose of rolling himself on the ground, and of crushing the bees. He returns to the charge so often, that he obliges them to abandon the hive, which he soon uncovers, and devours both the honey and the wax. Some time before the female brings forth, she retires, and seldom leaves her hole, where she prepares a bed for her young. When she perceives that her retreat is discovered, and that her young have been disturbed, she carries them off, one by one, into new habitation. The fox sleeps in a round form, like the dog; but, when he only reposes himself, he lies on his belly with his hind-legs extended. It is in this situation that he eyes the birds on the hedges and trees. The birds have such an antipathy against him, that they no sooner perceive him than they send forth shrill cries

to

to advertise their neighbours of the enemy's approach. The jays and black-birds, in particular, follow the fox from tree to tree, sometimes two or three hundred paces, often repeating the watch-cries. The Count de Buffon kept two young foxes, which, when at liberty, attacked the poultry; but, after they were chained, they never attempted to touch a single fowl. A living hen was fixed near them for whole nights; and, though destitute of victuals for many hours, in spite of hunger and of opportunity, they never forgot that they were chained, and gave the hen no disturbance.

In Kamtschatka, the animals called *gluttons* employ a singular stratagem for killing the fallow-deer. They climb up a tree, and carry with them a quantity of that species of moss of which the deer are very fond. When a deer approaches near the tree, the glutton throws down the moss. If the deer stops to eat the moss, the glutton instantly darts down upon his back, and, after fixing himself firmly between the horns, tears out its eyes, which torments the animal to such a degree, that, whether to
put

put an end to its torments, or to get rid of its cruel enemy, it strikes its head against the trees till it falls down dead. The glutton divides the flesh of the deer into convenient portions, and conceals them in the earth to serve for future provisions. The gluttons on the river Lena kill horses in the same manner*.

There are several species of rats in Kamtschatka. The most remarkable kind is called *tegulchitch* by the natives. These rats make neat and spacious nests under ground. They are lined with turf, and divided into different apartments, in which the rats deposit stores of provisions for supporting them during the winter. It is worthy of remark, that the rats of this country never touch the provisions laid up for the winter, except when they cannot procure nourishment any where else. These rats, like the Tartars, change their habitations. Sometimes they totally abandon Kamtschatka for several years, and their retreat greatly alarms the inhabitants, which they consider as a presage of a rainy season, and of a bad year for hunting. The return of these animals is;

VOL. II.

R

of

* Gazette Literaire, vol. 1. page 481.

of course, looked upon as a good omen. Whenever they appear, the happy news is soon spread over all parts of the country. They always take their departure in the spring, when they assemble in prodigious numbers, and traverse rivers, lakes, and even arms of the sea. After they have made a long voyage, they frequently lie motionless on the shore, as if they were dead. When they recover their strength they recommence their march. The inhabitants of Kamtschatka are very solicitous for the preservation of these animals. They never do the rats any injury, but give them every assistance when they lie weakened and extended on the ground. They generally return to Kamtschatka about the month of October; and they are sometimes met with in such prodigious numbers that travellers are obliged to stop two hours till the whole troop passes. The track of ground they travel in a single summer is not less wonderful than the regularity they observe in their march, and that instinctive impulse which enables them to foresee, with certainty, the changes of times and of seasons.

With

With regard to *Birds*, their artifices are not less numerous nor less surprising than those of quadrupeds. The eagle and hawk kinds are remarkable for the sharpness of their sight and the arts they employ in catching their prey. Their movements are rapid or slow, according to their intentions, and the situation of the animals they wish to devour. Rapacious birds uniformly endeavour to rise higher in the air than their prey, that they may have an opportunity of darting forcibly down upon it with their pounces. To counteract these artifices, Nature has endowed the smaller and more innocent species of birds with many arts of defence. When a hawk appears, the small birds, if they find it convenient, conceal themselves in hedges or brush-wood. When deprived of this opportunity, they often, in great numbers, seem to follow the hawk, and to expose themselves unnecessarily to danger, while, in fact, by their numbers, their perpetual changes of direction, and their uniform endeavours to rise above him, they perplex the hawk to such a degree, that he is unable to fix upon a single ob-

ject; and, after exerting all his art and address, he is frequently obliged to relinquish the pursuit. When in the extremity of danger, and after employing every other artifice in vain, small birds have been often known to fly to men for protection. This is a plain indication that these animals, though they in general avoid the human race, are by no means so much afraid of man as of rapacious birds.

The ravens often frequent the sea-shores in quest of food. When they find their inability to break the shells of muscles, &c, to accomplish this purpose they use a very ingenious stratagem: They carry a muscle, or other shell-fish, high up in the air, and then dash it down upon a rock, by which means the shell is broken, and they obtain the end they had in view.

The wood-pecker is furnished with a very long and voluble tongue. It feeds upon ants and other small insects. Nature has endowed this bird with a singular instinct. It knows how to procure food without seeing its prey. It attaches itself to the trunks or branches of decayed trees; and, wherever it perceives a hole or crevice, it darts
in

in its long tongue, and brings it out loaded with insects of different kinds. This operation is certainly instinctive; but the instinct is assisted by the instruction of the parents; for the young are no sooner able to fly, than the parents, by the force of example, teach them to resort to trees, and to insert their tongues indiscriminately into every hole or fissure.

Of the oeconomy of *Fishes*, as formerly remarked, our knowledge is extremely limited. But as the ocean exhibits a perpetual and a general scene of attack and defence, the arts of assault and of evasion must, of course, be exceedingly various. For the preservation of some species of fishes, Nature has armed them with strong and sharp pikes. Others, as the perch kind, are defended with strong bony rays in their fins. Others, as the univalve shell-fish, retire into their shells upon the approach of danger. The bivalves and multivalves, when attacked, instantly shut their shells, which, in general, is a sufficient protection to them. Some univalves, as the limpet-kind, attach themselves so firmly, by excluding the air, to rocks and stones, that, unless
quickly

quickly surpris'd, no force inferior to that of breaking the shell can remove them. The flying-fish, when pursu'd, darts out of the water, and takes refuge in the air, in which it is for some time supported by the operation of its large and pliable fins. The torpedo is furnished with a remarkable apparatus for self-preservation: It repels every hostile attempt by an electrical stroke, which confounds and intimidates its enemies. Several fishes, and particularly the salmon kind, when about to generate, leave the ocean, ascend the rivers, deposit their eggs in the sand, and, after making a proper *nidus* for their future progeny, return to the ocean from whence they came. Others, as the herring-kind, though they seldom go up rivers, assemble in myriads from all quarters, and approach the shores, or ascend arms of the sea, for the purpose of propagating the species, and cherishing their offspring. When that operation is performed, they leave the coasts and disperse in the ocean, till the same instinctive impulse forces them to observe a similar conduct next season. This migration
of

of falmons, herrings, and many other fishes, from the ocean to the rivers or shores, is of infinite advantage to mankind. They supply us occasionally, and in some countries, as Great Britain, and particularly Scotland, with abundance of nourishing and luxurious food; and, if our fisheries were once put upon a proper footing, they would soon constitute one of the most powerful incentives to industry, and become a great and important source of national strength and prosperity.

The *insect* tribes, though comparatively diminutive, are not deficient in artifice and address. With much art the spider spins his web. It serves him the double purpose of an habitation, and of a machine for catching his food. With incredible patience and perseverance he lies in the center of his web for days, and sometimes for weeks, before an ill-fated fly happens to be entangled. One species of spider, which is small, of a blackish colour, and frequents cottages or out-houses, I have known to live during the whole winter months without almost the possibility of receiving any nourishment; for, during that period, not a fly of any
kind

kind could be discovered in the apartment. If they had been fixed in a torpid state, like some other animals, the wonder of their surviving the want of food so long would not have been so great. But, in the severest weather, and through the whole course of the winter, they were perfectly active and lively. Neither did they seem to be in the least emaciated.

The *formica-leo*, or ant-lion, is a small insect, somewhat resembling a wood-louse, but larger. Its head is flat, and armed with two fine moveable crotchets or pincers. It has six legs, and its body, which terminates in a point, is composed of a number of membranous rings. In the sand, or in finely pulverised earth, this animal digs a hole in the form of a funnel, at the bottom of which it lies in ambush for its prey. As it always walks backward, it cannot pursue any insect. To supply this defect, it lays a snare for them, and especially for the ant, which is its favourite food. It generally lies concealed under the sand in the bottom of its funnel or trap, and seldom exhibits more than the top of its head. In digging a funnel, the *formica-leo* begins

beings with tracing a circular furrow in the sand, the circumference of which determines the size of the funnel, which is often an inch deep. After the first furrow is made, the animal traces a second, which is always concentric with the first. It throws out the sand, as with a shovel, from the successive furrows or circles, by means of its square flat head and one of its fore-legs. It proceeds in this manner till it has completed its funnel, which it does with surprising promptitude and address. At the bottom of this artful snare it lies concealed and immoveable. When an ant happens to make too near an approach to the margin of the funnel, the sides of which are very steep, the fine sand gives way, and the unwary animal tumbles down to the bottom. The formica-leo instantly kills the ant, buries it under the sand, and sucks out its vitals. It afterwards pushes out the empty skin, repairs the disorder introduced into its snare, and again lies in ambush for a fresh prey.

We formerly took some notice of that species of spider which carries her eggs in a bag attached to her belly. A spider of
this

this kind was thrown into the funnel of a formica-leo. The latter instantly seized the bag of eggs, and endeavoured to drag it under the sand. The spider, from a strong love of offspring, allowed its own body to be carried along with the bag. But the slender filk by which it was fixed to the animal's belly broke, and a separation took place. The spider immediately seized the bag with her pincers, and exerted all her efforts to regain the object of her affections. But these efforts were ineffectual; for the formica-leo gradually sunk the bag deeper and deeper in the sand. The spider, however, rather than quit her hold, allowed herself to be buried alive. In a short time, the observer removed the sand, and took out the spider. She was perfectly unhurt; for the formica-leo had not made any attack upon her. But, so strong was her attachment to her eggs, that, though frequently touched with a twig, she would not relinquish the place which contained them*.

When

* Oeuvres de Bonnet, vol. 4. page 295. 8vo. edit. Amsterdam 1769.

When arrived at its full growth, the formica-leo gives up the business of an ensnaring hunter. He deserts his former habitation, and crawls about for some time on the surface of the earth. He at last retires under the ground, spins a round silken pod, and is soon transformed into a fly.

CHAP.

CHAPTER XVI.

Of the Society of Animals.

THE associating principle, from which so many advantages are derived, is not confined to the human species, but extends, in some instances, to every class of animals.

It is remarked by Buffon, and some other authors, that the state of Nature, which had long occupied the attention and researches of philosophers, was rejected by them after the discovery was made. In the estimation of the authors alluded to, the savage state is the state of Nature. The first natural condition of mankind is the union of a male and a female. These produce a family, who, from necessity, or, in other words, from parental and filial affection, continue together, and assist each other in procuring food and shelter. This family, like most families in established civil societies, feel their own weakness, and their inability to supply their wants without more powerful resources than their feeble exertions.

tions. When this wandering and defenceless family accidentally meet with another family in the same condition, Nature, it is said, teaches them to unite for mutual support and protection. The association of two families may be considered as the first formation of a tribe or nation. When a number of tribes happen to unite, they only become a larger or more numerous nation. A single pair, it is true, if placed in a situation where plenty of food could be procured without much labour, might, in a succession of ages, produce any indefinite number. This is precisely the situation in which Moses has placed our first parents. He has added another circumstance highly favourable to a speedy population. Instead of the present brevity of human life, he informs us, that men, in the first periods of the world, lived and propagated several hundred years.

In countries thinly peopled with savages, it is extremely probable, that societies are formed by the gradual union of families and tribes. The increase of power arising from mutual assistance, and a thousand other comfortable circumstances, soon contribute to cement more firmly the associated members. Some of the
arts

arts of life, beside that of hunting, are occasionally discovered either by accident or by the ingenuity of individuals. In this manner, gradual advances are made from the savage to the civilized condition of mankind. This is a very short view of the origin of society, which has been adopted by most authors both ancient and modern, though many of them have derived the associating principle from very different, and even from opposite causes, which it is no part of our plan either to enumerate or refute. Some writers, as Aristotle, and a few moderns, implicit followers of his opinions, deny that man is naturally a gregarious or associating animal. To render this notion consistent with the actual and universal state of the human race, these authors have had recourse to puerile conceits, and to questionable facts, which it would be fruitless to relate. Other writers, possessed of greater judgment and discernment, and less warped with vanity and hypothetical phantoms, have derived the origin of society from its real and only source, Nature herself.

That the associating principle is instinctive hardly requires a proof. An appeal to the feelings of any human being, and to the universal

verfal condition of mankind, is fufficient. Thefe feelings, it may be faid, are acquired by education and habit. By thefe caufes, it is true, our focial feelings are ftrengthened and confirmed; but their origin is coeval with the exiftence of the firft human mind. Let any man attend to the eyes, the features, and the geftures of a child upon the breaft, when another child is prefented to it; both infantly, previous to the poffibility of inftruction or habit, exhibit the moft evident expreffions of joy. Their eyes sparkle, their features and geftures demonftrate, in the moft unequivocal manner, a mutual attachment, and a ftrong defire of approaching each other, not with a hostile intention, but with an ardent affection, which, in that pure and uncontaminated ftate of our being, does honour to human nature. When farther advanced, children who are ftrangers to each other, though their focial appetite is equally ftrong, difcover a mutual fhynefs of approach. This fhynefs or modefty, however, is foon conquered by the more powerful inftinct of affociation. They daily mingle and fport together. Their natural affections, which, at that period, are ftrong, and unbiaffed by thofe felfifh and vicious motives which too often

often conceal and thwart the intentions of Nature, create warm friendships that frequently continue during their lives, and produce the most beneficial and cordial effects. When we thus see with our eyes, that the associating principle appears at a period much more early than many of our other instincts, who will listen to those writers who choose to deny that man is, naturally, an associating or gregarious animal?

With regard to the advantages we derive from association, a volume would not be sufficient to enumerate them. Man, from the comparatively great number of instincts with which his mind is endowed, necessarily possesses a portion of the reasoning faculty highly superior to that of any other animal. He alone enjoys the power of communicating and expressing his ideas by articulate and artificial language. This inestimable prerogative is, perhaps, one of the greatest secondary bonds of society, and the greatest source of improvement to the human intellect. Without artificial language, though Nature has bestowed on every animal a mode of expressing its wants and desires, its pleasures and pains,
what

what an humiliating figure would the human species exhibit, even upon the supposition that they did associate? But, when language and association are conjoined, the human intellect, in the progress of time, arrives at a high degree of perfection. Society gives rise to virtue, honour, government, subordination, arts, science, order, happiness. All the individuals of a community conduct themselves upon a regulated system. Under the influence of established laws, kings and magistrates, by the exercise of legal authority, encourage virtue, repress vice, and diffuse, through the extent of their jurisdictions, the happy effects of their administration. In society, as in a fertile climate, human talents germinate and are expanded; the mechanical and liberal arts flourish; poets, orators, historians, philosophers, lawyers, physicians, and theologians, are produced. These truths are pleasant; and it were to be wished that no evils accompanied them. But, through the whole extent of Nature, it should appear, from our limited views, that good and evil, pleasure and pain, are necessary and perpetual concomitants.

The advantages of society are immense and invaluable. But the inconveniencies, hardships, injustice, oppressions, and cruelties, which too often originate from it, are great and lamentable. Even under the mildest and best regulated governments, animosities, jealousies, avarice, fraud, and chicane, are unfortunately never removed from our observation. In absolute monarchies, and particularly in despotic governments, the scenes of private and of general calamity and distress are often too dreadful to be described. Notwithstanding all these disadvantages, however, any government is preferable to anarchy; and the comforts, pleasures, and improvements, we receive from associating with each other, overbalance all the evils to which society gives rise.

From an attentive observation of the manners and oeconomy of animals, society has been distinguished into two kinds, which have been called *proper*, and *improper*. 1. *Proper Societies*, comprehend all those animals who not only live together in numbers, but carry on certain operations which have a direct tendency to promote the welfare and happiness of the community. 2. *Improper Societies*, include

clude all those animals who herd together, and love the company of each other, without carrying on any common operations.

1. *Proper Societies.*—It is almost needless to remark that man holds the first rank in animal associations of this kind. If men did not assist each other, no operation of any magnitude, or which could show any great superiority of talents above those of the brute creation, could possibly be effected. A single family, or even a few families united, like other carnivorous animals, might hunt their prey, and procure a sufficient quantity of food. They might, like the bear, lodge in the cavities of trees; they might occupy natural caves in the rocks; they might even build huts with branches of trees and with turf, and cement these gross materials with clay. This lowest and most abject view of human nature is not exaggerated. It were to be wished that this groveling condition of mankind were fictitious, and that, in many regions of the globe, it did not, at this moment, exist. These operations of men, when only acquainted with the mere rudiments of society, indicate parts little superior to those of the brutes. Man, even in his most uninformed state, possesses

the instincts, or the germs, of every species of knowledge and of genius. But they must be cherished, expanded, and brought gradually to perfection. It is by numerous and regularly established societies alone that such glorious exhibitions of human intellect can be produced. What is the hut of a savage when compared to the palace of a prince? or what his canoe when compared to a first rate ship of war?

Next to the intelligence exhibited in human society, that of the beavers is the most conspicuous. Their operations in preparing, fashioning, and transporting, the heavy materials for building their winter habitations, as formerly remarked*, are truly astonishing; and, when we read their history, we are apt to think that we are perusing the history of man in a period of society not inconsiderably advanced. It is only by the united strength, and co-operation of numbers, that the beavers could be enabled to produce such wonderful effects; for, in a solitary state, as they at present appear in some northern parts of Europe, the beavers, like solitary savages, are
timid

* See above, page 80, &c.

timid and stupid animals. They neither associate, nor attempt to construct villages, but content themselves with digging holes in the earth. Like men under the oppression of despotic governments, the spirit of the European beavers is depressed, and their genius is extinguished by terror, and by a perpetual and necessary attention to individual safety. The northern parts of Europe are now so populous, and the animals there are so perpetually hunted for the sake of their furs, that they have no opportunity of associating; of course, those wonderful marks of their sagacity, which they exhibit in the remote and uninhabited regions of North America, are no longer to be found. The society of beavers is a society of peace and of affection. They never quarrel or injure one another, but live together in different numbers, according to the dimensions of particular cabins, in the most perfect harmony. The principle of their union is neither monarchical nor despotic. For the inhabitants of the different cabins, as well as those of the whole village, seem to acknowledge no chief or leader whatever. Their association presents to our observation a model of a pure and perfect republic, the only basis of which is
mutual

mutual and unequivocal attachment. They have no law but the law of love and of parental affection. Humanity prompts us to wish that it were possible to establish republics of this kind among mankind. But the dispositions of men have little affinity to those of the beavers.

The hamster, or German marmot, and some other quadrupeds of this kind, live in society, and assist each other in digging and rendering commodious their subterraneous habitations. The operations of the marmots have already been described; and the nature of their society, as they continue during the winter in a torpid state, is either less known, or does not excite so much admiration as that of the beavers.

Pairing birds, in some measure, may be considered as forming proper societies; because, in general, the males and females mutually assist each other in building nests and feeding their young. But this society, except in the eagle tribes, commonly continues no longer than their mutual offspring are fully able to provide for themselves. None of the feathered tribes, as far as we know, unite in bodies,

in

in order to carry on any operation common to the whole.

Neither do we learn from history that fishes ever associate for the purpose of executing any common operation. Many of them, as herrings, salmon, &c. assemble in multitudes at particular seasons of the year; but this association, to which they are impelled by instinct, has no common object; for each individual is stimulated to act in this manner by its own motives, and no general effect is produced by mutual exertions.

In proper societies, each individual not only attends to his own preservation and welfare, but all the members co-operate in certain laborious offices which produce many common advantages that could not otherwise be procured. In some societies, the general principle of association and of mutual labour is purely instinctive, though, in many cases, individuals learn, by observation and experience, to modify or accommodate this general principle according to particular accidents or circumstances; some examples of which have already been given in the chapter upon instinct.

The

The insect tribes furnish many instances of proper societies. The honey-bees not only labour in common with astonishing assiduity and art, but their whole attention and affections seem to centre in the person of the queen or sovereign of the hive. She is the basis of their association and of all their operations. When she dies by any accident, the whole community are instantly in disorder. All their labours cease. No new cells are constructed. Neither honey nor wax are collected. Nothing but perfect anarchy prevails, till a new queen or female is obtained. The government or society of bees is more of a monarchical than of a republican nature. The whole members of the state seem to respect and to be directed by a single female. This fact affords a strong instance of the force and wisdom of Nature. The female alone is the mother of the whole hive, however numerous. Without her the species could not be continued. Nature, therefore, has endowed the rest of the hive with a wonderful affection to their common parent. For the reception of her eggs Nature impells them to construct cells, and to lay up stores of provisions for winter subsistence. These operations proceed from
pure

pure instinctive impulses. But every instinct necessarily supposes a degree of intellect, a substratum to be acted upon, otherwise no impulse could be felt, and, of course, no action nor mark of intelligence could possibly be produced.

That the intelligence, the government, and the sagacity of bees, have been frequently exaggerated, and as frequently misunderstood, no real philosopher, or natural historian, will pretend to deny. But the late ingenious Count de Buffon, through the whole of his great work, betrays the strongest inclination to deny that brutes, even those which are esteemed to be the most sagacious, as the dog, the elephant, &c. not to mention the inferior tribes, as birds, fishes, and insects, are endowed with the smallest portion of mind or intellect, but that all their movements, their expressions, their desires, their arts, are solely the results of mechanical impulses. The Count is peculiarly severe in his declamations against the sagacity of the honey-bees, and the celebrators of their oeconomy and manners. ‘ The genius
 ‘ of solitary bees,’ he remarks, ‘ is vastly inferior to that of the gregarious species; and
 ‘ the talents of those which associate in small
 ‘ troops

‘ troops are less conspicuous than of those
‘ that assemble in numerous bodies. Is not
‘ this alone sufficient to convince us, that the
‘ *seeming genius* of bees is nothing but a result
‘ of *pure mechanism*, a combination of move-
‘ ments proportioned to numbers, an effect
‘ which appears to be complicated, only be-
‘ cause it depends on thousands of individuals?
‘ It must, therefore, be admitted, that bees,
‘ taken separately, have less genius than the
‘ dog, the monkey, and most other animals: It
‘ will likewise be admitted, that they have less
‘ docility, less attachment, and less sentiment;
‘ and that they possess fewer qualities relative
‘ to those of the human species. Hence we
‘ ought to acknowledge, that their apparent
‘ intelligence proceeds solely from the *multitude*
‘ *united*. This union, however, presupposes
‘ not intellectual powers; for they unite not
‘ from moral views: They find themselves to-
‘ gether without their consent. This soci-
‘ ety, therefore, is a physical assemblage
‘ ordained by Nature, and has no depen-
‘ dence on knowledge or reasoning. The
‘ mother bee produces at one time, and in
‘ the same place, ten thousand individuals,
‘ which, though they were much more stupid
‘ than

‘ than I have supposed them, would be oblig-
‘ ed, solely for the preservation of their exist-
‘ ence, to arrange themselves into some order.
‘ As they all act against each other with equal
‘ forces, supposing their first movements to
‘ produce pain, they would soon learn to di-
‘ minish this pain, or, in other words, to af-
‘ ford mutual assistance: They, of course,
‘ would exhibit an air of intelligence, and of
‘ concurring in the accomplishment of the
‘ same end. A superficial observer would in-
‘ stantly ascribe to them views and talents
‘ which they by no means possess: He would
‘ explain every action: Every operation would
‘ have its particular motive, and prodigies of
‘ reason would arise without number; for ten
‘ thousand individuals produced at one time,
‘ and obliged to live together, must all act in
‘ the very same manner; and, if endowed
‘ with feeling, they must acquire the same
‘ habits, assume that arrangement which is
‘ the least painful, or the most easy to them-
‘ selves, labour in their hive, *return* after
‘ leaving it, &c. Hence the *origin* of the
‘ many wonderful talents ascribed to bees,
‘ such as their architecture, their geometry,
‘ their order, their foresight, their patriotism,
‘ and,

‘ and, in a word, their republic, the whole of
‘ which, as I have *proved*, has no existence
‘ but in the imagination of the observer *.’

That this mode of reasoning should have been seriously adopted by so great a literary character as that of the Count de Buffon, is truly astonishing. The substance of the argument is, that ten thousand bees, or other gregarious insects, when brought into existence at the same time, and in the same place, must necessarily, by the inconvenience or pain arising from mutual pressure, assume an arrangement, and construct commodious and artful habitations for the whole community. I hate polemical argumentation; and philosophical absurdities are the most difficult to refute. If ten thousand butterflies, or any other flies, whose instinctive or mental powers differed from those of the bee, should be brought forth at the same time, and in the same place, which might be easily effected by collecting their chrysalids, Would these animals, from the inconveniencies or pain they might suffer by being crowded together, assume a proper arrangement, and build habitations suited to their

* Translation, vol. 3. page 285.

their mutual comfort and preservation? No. If not allowed to escape from their present situation, they would suffocate each other; and, if any of them were permitted to get out of their prison, instead of returning, like the bees, they would avoid it with as much horror as a person who had made his escape from the Black Hole of Calcutta. No declamatory reasoning, however specious, will ever change the nature of truth. Without some portion of intellect, or what is synonymous, of mental powers, How should the different kinds of bees in the same hive be induced to perform so many different operations? While some are busily employed at home in the construction of cells, others are equally industrious in the fields collecting materials for carrying on the work. They are no sooner relieved from their load by their companions and fellow-labourers in the hive, than they again repair to the fields, and, with persevering industry, fly from flower to flower till they have amassed another load of materials, which they immediately transport to the hive. In this laborious office they persist for many hours every day when the weather permits. Will any man pretend to assert, that these, and many similar

similar operations performed by bees, are the results of mechanical impulses*? Are bees, when collecting honey, and the farina of flowers, at great distances from the hive, compelled, by the mechanical pressure of multitudes, to assume a certain arrangement, and all of them to act in the same manner? Can any animal be possessed of more liberty, or be more free from mechanical restraint, than a bee while roaming at large in the fields? Besides, What should force a bee, while wallowing in luxury, to return so repeatedly to the hive with no other view than to feed its companions, or to furnish them with materials for their work? Here every idea of mechanical impulse is utterly excluded. That bees, as well as other animals, are actuated by motives, or impulses, it is willingly allowed. But these are not mechanical impulses. They are the wise and irresistible impulses of Nature upon their minds. If bees did not associate, and mutually assist one another in their various operations, the species would soon be annihilated. Not one of them, it is probable, would survive

* For several curious operations of bees, which it will be difficult to reconcile with any principles of mechanism, the reader may consult page 119, &c.

survive the first winter. But Nature, ever solicitous for the preservation of her productions, has endowed their minds with an associating principle, and with instincts which stimulate them to perform all those wonderful operations that are necessary for the existence of individuals, and the continuation of the species.

What are called the *common* caterpillars afford an instance of proper association. About the middle of summer, a butterfly deposits from three to four hundred eggs on the leaf of a tree, from each of which, in a few days, a young caterpillar proceeds. They are no sooner hatched than they begin to form a common habitation. They spin filken threads, which they attach to one edge of the leaf, and extend them to the other. By this operation they make the two edges of the leaf approach each other, and form a cavity resembling a hammock. In a short time, the concave leaf is completely roofed with a covering of silk. Under this tent the animals live together in mutual friendship and harmony. When not disposed to eat or to spin, they retire to their tent. It requires several of these habitations to contain the whole. According as
the

the animals increase in size; the number of their tents is augmented. But these are only temporary and partial lodgements, constructed for mutual conveniency, till the caterpillars are in a condition to build one more spacious, and which will be sufficient to contain the whole. After gnawing one half of the substance of such leaves as happen to be near the end of some twig or small branch, they begin their great work. In constructing this new edifice or nest, the caterpillars encrust a considerable part of the twig with white silk. In the same manner, they cover two or three of such leaves as are nearest to the termination of the twig. They then spin silken coverings of greater dimensions, in which they inclose the two or three leaves together with the twig. The nest is now so spacious that it is able to contain the whole community, every individual of which is employed in the common labour. These nests are too frequently seen, in autumn, upon the fruit-trees of our gardens. They are still more exposed to observation in winter, when the leaves, which formerly concealed many of them, are fallen. They consist of large bundles of white silk and withered leaves, without any regular or constant form.

form. Some of them are flat, and others roundish; but none of them are destitute of angles. By different plain coverings extended from the opposite sides of the leaves and of the twig, the internal part of the nest is divided into a number of different apartments. To each of these apartments, which seem to be very irregular, there are passages by which the caterpillars can either go out in quest of food, or retire in the evening, or during rainy weather. The silken coverings, by repeated layers, become at last so thick and strong, that they resist all the attacks of the wind, and all the injuries of the air, during eight or nine months. About the beginning of October, or when the frost first commences, the whole community shut themselves up in the nest. During the winter they remain immoveable, and seemingly dead. But, when exposed to heat, they soon discover symptoms of life, and begin to creep. In this country, they seldom go out of the nest till the middle or end of April. When they shut themselves up for the winter, they are very small; but, after they have fed for some days in spring upon the young and tender leaves, they find the nest itself, and all the entrances to it, too small

for the increased size of their bodies. To remedy this inconveniency, these disgusting reptiles know how to enlarge both the nest and its passages by additional operations accommodated to their present state. Into these new lodgings they retire when they want to repose, to screen themselves from the injuries of the weather, or to cast their skins. In fine, after casting their skins several times, the time of their dispersion arrives. From the beginning to near the end of June, they lead a solitary life. Their social disposition is no longer felt. Each of them spins a pod of coarse brownish silk. In a few days they are changed into chrysalids; and, in eighteen or twenty days more, they are transformed into butter-flies.

Caterpillars of another species, which Reaumur distinguishes by the appellation of the *processionary caterpillar*, live in society till their transformation into flies. These caterpillars are of the hairy kind, and are of a reddish colour. They inhabit the oak, and feed upon its leaves. When very young, they have no fixed or general habitation. But, after they have acquired about one half of their natural size, they assemble together, and construct a
nest

nest sufficient to accommodate the whole. The nests of these caterpillars are attached to the trunks of the oak, and are situated sometimes near the earth, and sometimes seven or eight feet above its surface. They consist of different strata, or layers, of filk, which are spun by the united labour of the whole community. Their figure is neither striking nor uniform. On the part of the oak to which they are fixed they form a protuberance similar to those knots which are seen upon trees. This protuberance sometimes resembles a segment of a circle, and sometimes it is three or four times longer than it is broad. Some of these nests are from eighteen to twenty inches long, and from five to six inches wide. About the middle of their convexity, they often rise more than four inches above the surface of the tree. Between the trunk of the tree and the layers of filk a single hole is left, to allow the animals to go out in quest of food, and to retire into the nest after they are satiated. Notwithstanding the great bulk of these nests, and though there are often three or four of them upon the same tree, and never elevated above the height of distinct vision, they are not easily perceived; for

the silk of which they are composed is cinereous, and resembles, in colour, those mosses with which the trunk of the oak is generally covered.

The inhabitants of a nest, which are numerous, march out, about the setting of the sun, to forage, under the conduct of a chief or leader, all whose movements they uniformly follow. The order they observe is singular. The first rank consists of single animals, the second of two, the third of three, the fourth of four, and sometimes more. In this manner they proceed in quest of food with all the regularity of 'disciplined troops. The chief or leader has no marks of pre-eminence; for any individual that happens first to issue from the nest, from that circumstance alone, becomes the leader of an expedition. After making a full repast upon the neighbouring leaves, they return to the nest in the same regular order; and this practice they continue during the whole period of their existence in the caterpillar state. It was from this strange regularity of movement that Reaumur, with much propriety, denominated these animals *processionary* caterpillars. When arrived at maturity, each individual spins

spins a silken pod, is converted into a chrysalis, and afterwards assumes the form of a butterfly. This last transformation breaks all the bonds of their former association, and the female flies deposit their eggs, which, when hatched, produce new colonies, who exhibit the same oeconomy and manners.

There are several species of caterpillars who are real republicans, and whose discipline, manners, and genius, are equally diversified as those of the inhabitants of different nations and climates. Some, like particular savages, construct a kind of hammocks, in which they take their victuals, repose, and spend their lives till the period of their transformation. Others, like the Arabs and Tartars, construct and live in silken tents, and, after consuming the neighbouring herbage, they leave their former habitations, and encamp on fresh pasture. Under these tents they are not only protected from the injuries of the weather, but they repose in them when sick, or in a state of inactivity. They go out of their tents at particular times in quest of food, and often to considerable distances; but they never lose their way back. It is not by sight that they are directed with so much certainty to their abodes.

abodes. Nature has furnished them with another guide for regaining their habitations. We pave all our streets with stones; but the caterpillars cover all their roads with filken threads. These treads make white tracks, which are often more than a sixth of an inch wide. It is by following these filken tracks, however complicated, that the caterpillars never miss their nests. If the road is broke by a man's finger drawn along it, or by any other accident, the caterpillars are greatly embarrassed. They stop suddenly at the interrupted space, and exhibit every mark of fear and of diffidence. Here the march stops, till an individual, more bold or more impatient than his companions, traverses the gap. In his passage, he leaves behind him a thread of silk, which serves as a bridge or conductor to the next that follows. By the progression of numbers, each of which spins a thread, the breach is soon repaired. We cannot suppose that these stupid animals cover their roads to prevent their wandering. But they never wander, because their roads are covered with silk. In this, as well as in many other instances, Nature obliges animals to embrace the most effectual means of self-preservation,

vation, and even of conveniency, without their perceiving the utility of their own operations. The caterpillars, whose manners we have been describing, spin almost continually, because they are continually obliged to evacuate a filky matter, secreted from their food by vessels destined for that purpose, and included in their intestines. In obeying this call of Nature, they effectually secure their retreat to their nests, and perhaps their existence. It may be said, that caterpillars associate for no other reason but because they are all produced at the same time from eggs deposited near each other. But many other species of caterpillars, who are brought to life in the very same circumstances, never associate or act in concert in the performance of any mutual labour. The silk-worms afford a similar example. It is true, they spontaneously remain assembled in the same place, which is of great advantage to manufacture. But the individuals of other species disperse immediately after birth, and never re-unite. Spiders, when newly hatched, begin with spinning a web in common; but they soon terminate this association by devouring one another.

As

As caterpillars do not engender till they arrive at the butterfly state, their associations have no respect to the rearing or education of young. Self-preservation and individual conveniency are the only bonds of their union. A perfect equality reigns among them, without any distinction of sex, or even of size. Each takes his share of the common labour; and the whole society, which constitutes but one family, is the genuine issue of the same mother.

The association and oeconomy of the common ants merit some attention. With wonderful industry and activity they collect materials for the construction of their nest. They unite in numbers, and assist each other in excavating the earth, and in transporting to their habitation bits of straw, small pieces of wood, and other substances of a similar kind, which they employ in lining and supporting their subterraneous galleries. The form of their nest or hill is somewhat conical, and, of course, the water, when it rains, runs easily off, without penetrating their abode. Under this hill there are many galleries or passages which communicate
with

with each other, and resemble the streets of a small city.

The ants not only associate for the purpose of constructing a common habitation, but for cherishing and protecting their offspring. Every person must have often observed, when part of a nest is suddenly exposed, their extreme solicitude for the preservation of their chrysalids or nymphs, which often exceed the size of the animals themselves. With amazing dexterity and quickness the ants transport their nymphs into the subterraneous galleries of the nest, and place them beyond the reach of any common danger. The courage and fortitude with which they defend their young is no less astonishing. The body of an ant was cut through the middle, and, after suffering this cruel treatment, so strong was its parental affection, with its head, and one half of the body, it carried off eight or ten nymphs. They go to great distances in search of provisions. Their roads, which are often winding and involved, all terminate in the nest.

The wisdom and foresight of the ants have been celebrated from the remotest antiquity,

tiquity. It has been asserted and believed, for near three thousand years, that they lay up magazines of provisions for the winter, and that they even cut off the germ of the grain to prevent it from shooting. But the ancients were never famed for accurate researches into the nature and operations of insects. These supposed magazines could be of no use to the ants; for, like the marmots and dormice, they sleep during the winter. A very moderate degree of cold is sufficient to render them torpid. In fact, it is now well known that they amass no magazines of provisions. The grains which, with so much industry and labour, they carry to their nest, are not intended to be food to the animals, but, like the bits of straw and wood, are employed as materials in the construction of their habitation.

2. *Improper Societies.*—Many animals are gregarious, though they unite not with a view to any joint operation, such as constructing common habitations, or mutually and indiscriminately nourishing and protecting the offspring produced by the whole society.

society. But, even among animals of this description, there are motives or bonds of association, and, in many instances, they mutually assist and defend each other from hostile assaults.

The ox is a gregarious animal. When a herd of oxen are pasturing in a meadow, if a wolf makes his appearance, they instantly form themselves in battle array, and present their united horns to the enemy. This warlike disposition often intimidates the wolf, and obliges him to retire.

In winter, the hinds and young stags associate, and form herds which are always more numerous in proportion to the severity of the weather. One bond of their society seems to be the advantage of mutual warmth derived from each other's bodies. In spring they disperse, and the hinds conceal themselves in the forests, where they bring forth their young. The young stags, however, continue together; they love to browse in company; and necessity alone forces them to separate.

The Count de Buffon represents sheep as stupid creatures, which are incapable of defending themselves against the attacks of any rapacious

rapacious animal. He maintains that the race must long ago have been extinguished, if man had not taken them under his immediate protection. But Nature has furnished every species of animated beings with weapons and arts of defence which are sufficient for individual preservation as well as the continuation of the kind. Sheep are endowed with a strong associating principle. When threatened with an attack, like soldiers, they form a line of battle, and boldly face the enemy. In a natural state, the rams constitute one half of the flock. They join together and form the front. When prepared in this manner for repelling an assault, no lion or tiger can resist their united impetuosity and force.

A family of hogs, when in a state of natural liberty, never separate till the young have acquired strength sufficient to repel the wolf. When a wolf threatens an attack, the whole family unite their forces, and bravely defend each other.

The wild dogs of Africa hunt in packs, and carry on a perpetual war against other rapacious animals. The jackals of Asia and Africa likewise hunt in packs. But, though animals of this kind mutually assist each other in killing prey,

prey, individual advantage is the chief, if not the only bond of this temporary union.

Another kind of society is observable among domestic animals. Horses and oxen, when deprived of companions of their own species, associate, and discover a visible attachment. A dog and an ox, or a dog and a cow, when placed in certain circumstances, though the species are remote, and even hostile, acquire a strong affection for each other. The same kind of association takes place between dogs and cats, between cats and birds, &c. If domestic animals had a strong aversion to one another, man could not derive so many advantages from them. Horses, oxen, sheep, &c. by browsing promiscuously together, augment and meliorate the common pasture. By living under the same roof, and feeding in common, this associating principle is strengthened and modified by habit, which often commences immediately after birth. A single horse confined in an inclosure, discovers every mark of uneasiness. He becomes restless, neglects his food, and breaks through every fence in order to join his companions in a neighbouring field. Oxen and cows will not fatten in the finest pasture, if they are deprived of society.

From

From the facts and remarks contained in this chapter, it seems to be evident, that the principle of association in man, as well as in many other animals, is purely instinctive; and that this principle may be strengthened and modified by the numberless advantages derived from it, by imitation, by habit, and by many other circumstances.

CHAPTER XVII.

Of the Docility of Animals.

OF all animals capable of culture man is the most ductile. By instruction, imitation, and habit, his mind may be moulded into any form. It may be exalted by science and art to a degree of knowledge, of which the vulgar and uninformed have not the most distant conception. The reverse is melancholy. When the human mind is left to its own operations, and deprived of almost every opportunity of social information, it sinks so low, that it is nearly rivaled by the most sagacious brutes. The natural superiority of man over the other animals, as formerly remarked, is a necessary result of the great number of instincts with which his mind is endowed. These instincts are gradually unfolded, and produce, after a mature age, reason, abstraction, invention, science. To confirm this truth, it would be fruitless to have recourse to metaphysical arguments, which generally mislead and bewilder human

human reason. A diligent attention to the actual operations of Nature is sufficient to convince any mind that is not warped and deceived by popular prejudice, the fetters of authorities, as they are called, whether ancient or modern, or by the vanity of supporting preconceived opinions and favourite theories. Let any man reflect on the progress of children from birth to manhood. At first, their instincts are limited to obscure sensations, and to the performance of a few corporeal actions, to which they are prompted, or rather compelled, by certain stimulating impulses unnecessary to be mentioned. In a few months, their sensations are perceived to be more distinct, their bodily actions are better directed, new instincts are unfolded, and they assume a greater appearance of rationality and of mental capacity. When still farther advanced, and after they have acquired some use of language, and some knowledge of natural objects, they begin to reason; but their reasonings are feeble, and often preposterous. In this manner they uniformly proceed in improvement till they are actuated by the last instinct, at or near the age of puberty. After this period, they reason with some degree of perspicuity
and

and justness. But, though their whole instincts are now unfolded and in action, every power of their minds requires, previous to its utmost exertions, to be agitated and polished by an examination of a thousand natural and artificial objects, by the experience and observations of those with whom they associate, by public or private instruction, by studying the writings of their predecessors and contemporaries, and by their own reflections, till they arrive at the age of thirty-five. Previous to that period, much learning may have been acquired, much genius may have been exerted; but, before that time of life, judgment, abstraction, and the reasoning faculty, are not fully matured. This progress is the genuine operation of Nature, and the gradual source of human sagacity and mental powers. The same progress is to be observed in the powers of the body. It arrives, indeed, sooner at perfection than the mind. But, if the progress of the mind greatly preceded that of the body, what a miserable and awkward figure would human beings, at an early period of their existence, exhibit? Active and vigorous minds, stimulated to command what the organs of their bodies were unable to obey, would produce peevish-

ness, anger, regret, and every distressing passion.

The bodies of men, though not so ductile as their minds, are capable, when properly managed by early culture, of wonderful exertions. Men, accustomed to live in polished societies, have little or no idea of the activity, the courage, the patience, and the persevering industry of savages, when simply occupied in hunting wild animals for food to themselves and their families. The hunger, the fatigue, the hardships, which they not only endure, but despise with fortitude, would amaze and terrify the imagination of any civilized European.

Beside man, many other animals are capable of being instructed. The ape-kind, and especially the larger species of them, imitate the actions of men without any instruction. This imitation they are enabled to perform with the greater exactness, on account of their structure. The orang-outang, a native of the southern regions of Africa and India, is as tall and as strong as a man. He has no tail. His face is flat. His arms, hands, toes, and nails, are perfectly similar to ours. He walks constantly on end; and the features of his
visage

visage make a near approach to those of the human countenance. He has a beard on his chin, and no more hair on his body than men have when in a state of nature. He knows how to bear arms, to attack his enemies with stones, and to defend himself with a club. Of all the apes, the orang-outang, or *wild man*, as he is called by the Indians, has the greatest resemblance to man both in the structure of his body and in his manners. There are two supposed species of orang-outang, a larger and a smaller. The latter has been several times brought to Europe, and accurate descriptions has been given both of his external and internal parts. But, with regard to the larger kind, who is said to exceed the ordinary stature of man, we have nothing to rely on but the relations of travellers. Bontius, who was chief physician in Batavia, affirms expressly, that he saw, with admiration, several individuals of this species walking on their two feet. Among others, he remarked a female, who seemed to have a sense of modesty, who covered her face with her hands when men approached her with whom she was unacquainted, who wept, groaned, and seemed to want nothing of humanity but the

U 2

faculty

faculty of speech*. Many other surprising actions performed by this animal are recorded by different voyagers, which it is unnecessary to repeat, especially as we have a sufficient number of facts attested by unequivocal evidence. The Count de Buffon, with much probability, considers what are called the large and small orang-outangs to be the same species of animals; for those hitherto brought to Europe were very young, and had not acquired one half of their stature.

‘ The orang-outang,’ says Buffon, ‘ which I saw, walked always on two feet, even when carrying things of considerable weight. His air was melancholy, his movements measured, his dispositions gentle, and very different from those of other apes. He had neither the impatience of the Barbary ape, the maliciousness of the baboon, nor the extravagance of the monkeys. It may be alleged that he had the benefit of instruction; but the apes, which I shall compare with him, were educated in the same manner. Signs and words were alone sufficient
‘ to

* Jac. Bont. Hist. Nat. Ind. cap. 32.

‘ to make our ourang-outang act : But the ba-
‘ boon required a cudgel, and the other apes
‘ a whip ; for none of them would obey with-
‘ out blows. I have seen this animal present
‘ his hand to conduct the people who came to
‘ visit him, and walk as gravely along with
‘ them as if he had formed a part of the com-
‘ pany. I have seen him sit down at table,
‘ unfold his towel, wipe his lips, use a spoon
‘ or a fork to carry the victuals to his mouth,
‘ pour his liquor into a glass, and make it
‘ touch that of the person who drank along
‘ with him. When invited to drink tea, he
‘ brought a cup and a saucer, placed them on
‘ the table, put in sugar, poured out the tea,
‘ and allowed it to cool before he drank it.
‘ All these actions he performed without any
‘ other instigation than the signs or verbal or-
‘ ders of his master, and often of his own ac-
‘ cord. He did no injury to any person : He
‘ even approached company with circumspec-
‘ tion, and presented himself as if he wanted
‘ to be careffed. He was very fond of dain-
‘ ties, which every body gave him : And, as
‘ his breast was diseased, and he was afflicted
‘ with a teasing cough, this quantity of sweet-
‘ meats undoubtedly contributed to shorten
‘ his

‘ his life. He lived one summer in Paris, and
‘ died in London the following winter. He
‘ eat almost every thing ; but preferred ripe
‘ and dried fruits to all other kinds of food.
‘ He drank a little wine, but spontaneously
‘ ly left it for milk, tea, or other mild li-
‘ quors*.’

M. de la Brosse purchased two ourang-
outangs from a Negro, whose age exceeded not
twelve months. ‘ These animals,’ he re-
marks, ‘ have the instinct of sitting at table
‘ like men. They eat every kind of food with-
‘ out distinction. They use a knife, a fork,
‘ or a spoon, to cut or lay hold of what is
‘ put upon their plate. They drink wine
‘ and other liquors. We carried them aboard.
‘ At table, when they wanted any thing, they
‘ made themselves be understood by the cabin-
‘ boy: And, when the boy refused to give
‘ them what they demanded, they sometimes
‘ became enraged, seized him by the arm, bit,
‘ and threw him down.—The male was seiz-
‘ ed with sickness in the road. He made
‘ himself be attended as a human being. He
‘ was even twice bled in the right arm:
‘ And,

* Buffon, vol. 8. page 86. trans.

‘ And, whenever he found himself afterwards in the same condition, he held out his arm to be bled, as if he knew that he had formerly received benefit from that operation.’

We are informed by Francis Pyrard, ‘ that, in the province of Sierra-Leona, there is a species of animals called *baris*, (the orang-outang), who are strong and well limbed, and so industrious, that, when properly trained and fed, they work like servants; that they generally walk on the two hind-feet; that they pound any substances in a mortar; that they go to bring water from the river in small pitchers, which they carry full on their heads. But, when they arrive at the door, if the pitchers are not soon taken off, they allow them to fall; and, when they perceive the pitcher overturned and broken, they weep and lament *.’ With regard to the education of these animals, the testimony of Schoutton corresponds with that of Pyrard. ‘ They are taken,’ says he, ‘ with snares, taught to walk on their hind-feet, and to
‘ use

* Voyages de François Pyrard, tom. 2, page 331.

‘ use their fore-feet as hands in performing
‘ different operations, as rinsing glassess, car-
‘ rying drink round the company, turning
‘ a spit,’ &c.*. Guat informs us, that he
‘ saw at Java a very extraordinary ape. It
‘ was a female. She was very tall, and often
‘ walked erect on her hind-feet. On these oc-
‘ casions, she concealed with her hands the
‘ parts which distinguish the sex.—She made
‘ her bed very neatly every day, lay upon her
‘ side, and covered herself with the bed-clothes.
‘ When her head ached, she bound it up
‘ with her handkerchief; and it was amus-
‘ ing to see her thus hooded in bed. I could
‘ relate many other little articles which ap-
‘ peared to be extremely singular. But I ad-
‘ mired them not so much as the multitude;
‘ because, as I knew the design of bringing
‘ her to Europe to be exhibited as a shew, I
‘ was inclined to think that she had been
‘ *taught* many of these monkey tricks, which
‘ the people considered as being natural to
‘ the animal. She died in our ship, about the
‘ latitude of the Cape of Good Hope. The
‘ figure

* Voyages de Schoutton aux Indes Orientales.

‘ figure of this ape had a very great resemblance to that of man *.’

We have now enumerated the principal facts regarding this extraordinary animal, which have been related by voyagers of credit, and by those who have seen and examined him in Europe ; and shall only remark, that, notwithstanding the great similarity of his structure and organs to those of the human species, his genius and talents seem to be very limited. The form of his body enables him to imitate every human action. But, though he has the organs of speech, he is destitute of articulate language. If, however, he were domesticated, and proper pains bestowed for instructing him, he might unquestionably be taught to articulate. But, supposing this point to be obtained, if he remained incapable of reflection, if he was unable to comprehend the meaning of words, or to discover by his expressions a degree of intellect greatly superior to that of the brute creation, which I imagine would be the case, he could never, as some authors have held forth, be exalted to the distinguished rank of human beings.

Of

* Voyages de Fran. le Guat, tom. 2. page 96.

Of all quadrupeds, of whose history and manners we have any proper knowledge, the elephant is most remarkable both for docility and understanding. Though his size is enormous, and his members rude and disproportioned, which give him, at first sight, the aspect of dullness and stupidity, his genius is great, and his sagacious manners, and his sedate and collected deportment, are almost incredible. He is the largest and strongest of all terrestrial animals. Though naturally brave, his dispositions are mild and peaceable. He is an associating animal, and seldom appears alone in the forests. When in danger, or when they undertake a depredatory expedition into cultivated fields, the elephants assemble in troops. The oldest takes the lead; the next in seniority brings up the rear; and the young and the feeble occupy the center. In the forests and solitudes they move with less precaution; but never separate so far asunder as to render them incapable of affording each other mutual assistance when danger approaches. A troop of elephants constitutes a most formidable band. Wherever they march, the forest seems to fall before them. They bear down the
branches

branches upon which they feed ; and, if they enter an inclosure, they soon destroy all the labours of the husbandman. Their invasions are the more tremendous, as there is hardly any means of repelling them ; for, to attack a troop when thus united, would require a little army. It is only when one or two elephants happen to linger behind the rest, that the hunters dare exert their art and ingenuity in making an attack ; for any attempt to disturb the troop would certainly prove fatal to the assailants. When an insult is offered, the elephants instantly move forward against the offender, toss him in the air with their tusks, and afterwards trample him to pieces under their feet, or rather pillars of flesh and bone. Let not the character of this noble and majestic animal, however, be misrepresented. With force and dignity he resents every affront ; but, when not disturbed by petulance or actual injury, he never shows an hostile intention either against man or any other animal. Elephants live entirely on vegetables, and have no thirst for blood. Such is their social and generous disposition, that, when an individual chancs to meet with a luxurious spot of pasture, he immediately

ately calls to his companions, and invites them to partake of his good fortune.

The elephant possesses all the senses in perfection: But, in the sense of touching, he excels all the brute creation. His trunk is the chief instrument of this sense. In an elephant of fourteen feet high, the trunk is about eight feet long, and five feet and an half in circumference at the base. It is a large fleshy tube, divided through its whole extent by a septum or partition. It is capable of motion in every direction. The animal can shorten or lengthen it at pleasure. It answers every purpose of a hand; for it grasps large objects with great force, and its extremity can lay hold of a sixpence, or even of a pin. The trunk of the elephant affords him the same means of address as the ape. It serves the purposes of an arm and a hand. By this instrument, the elephant conveys large or small bodies to his mouth, places them on his back, embraces them fast, or throws them forcibly to a distance. In a state of nature and perfect freedom, the dispositions of the elephant are neither sanguinary nor ferocious. They are gentle creatures, and never exert their strength, or employ their weapons, but in defending

fending themselves or protecting their companions. Even when deprived of the instruction of men, they possess the sagacity of the beaver, the address of the ape, and the acuteness of the dog. To these mental talents are added the advantages of amazing bodily strength, and the experience and knowledge he acquires by living at least two centuries. With his trunk he tears up trees. By a push of his body he makes a breach in a wall. To this prodigious strength he adds courage, prudence, and coolness of deportment. As he never makes an attack but when he receives an injury, he is universally beloved; and all animals respect, because none have any reason to fear him. In all ages, men have entertained a veneration for this most magnificent and sagacious of terrestrial creatures. The ancients regarded him as a miracle of Nature, and he is, in reality, one of her greatest efforts. But they have greatly exaggerated his faculties. Without hesitation, they have ascribed to him high intellectual powers and moral virtues. Pliny, Ælian, Plutarch, and other authors of a more modern date, have bestowed on the elephant not only

rational

rational manners, but an innate religion, a kind of daily adoration of the sun and moon, the use of ablution before worship, a spirit of divination, piety toward heaven and their fellow creatures, whom they assist at the approach of death, and, after their decease, bedew them with tears, and cover their bodies with earth.

When tamed and instructed by man, the elephant is soon rendered the mildest and most obedient of all domestic animals. He loves his keeper, caresses him, and anticipates his commands. He learns to comprehend signs, and even to understand the expression of sounds. He distinguishes the tones of command, of anger, and of approbation, and regulates his actions by his perceptions. The voice of his master he never mistakes. His orders are executed with alacrity, but without any degree of precipitation. His movements are always measured and sedate, and his character seems to correspond with the gravity of his mass. To accommodate those who mount him, he readily learns to bend his knees. With his trunk he salutes his friends, uses it for raising burdens, and assists in loading himself. He loves to be clothed,
and

and seems to be proud of gaudy trappings. In the southern regions, he is employed in drawing waggons, ploughs, and chariots. 'I was eye-witness,' says P. Philippe, 'to the following facts. At Goa, there are always some elephants employed in the building of ships. I one day went to the side of the river, near which a large ship was building in the city of Goa, where there is a large area filled with beams for that purpose. Some men tie the ends of the heaviest beams with a rope, which is handed to the elephant, who carries it to his mouth, and, after twisting it round his trunk, draws it, without any conductor, to the place where the ship is building, though it had only once been pointed out to him. He sometimes drew beams so large that more than twenty men would have been unable to move. But, what surprised me still more, when other beams obstructed the road, he elevated the ends of his own beams that they might run easily over those which lay in his way. Could the most enlightened man do more*?' When at work, the elephant draws equally, and, if properly managed, never turns restive.

* Voyage d'Orient. page 367.

tive. The man who conducts the animal generally rides on his neck, and employs a hooked iron rod, or a bodkin, with which he pricks the head or sides of the ears, in order to push the creature forward, or to make him turn. But words are commonly sufficient. The attachment and affection of the elephant are sometimes so strong and durable that he has been known to die of grief, when, in an unguarded paroxysm of rage, he had killed his guide.

Before the invention of gun-powder, elephants were employed in war by the African and Asiatic nations. 'From time immemorial,' says Schouten, 'the Kings of Ceylon, of Pegu, and of Aracan, have used elephants in war. Naked sabres were tied to their trunks, and on their backs were fixed small wooden castles, which contained five or six men armed with javelins, and other weapons*.' The Greeks and Romans, however, soon became acquainted with the nature of these monstrous warriors. They opened their ranks to let the animals pass, and directed all their weapons, not against the

* Voyage de Schouten, page 32.

the elephants, but their conductors. Since fire has now become the element of war, and the chief instrument of destruction, elephants, who are terrified both at the flame and the noise, would be more dangerous than useful in our modern battles. The Indian Kings, however, still arm elephants in their wars. In Cochin, and other parts of Malabar, all the warriors who fight not on foot are mounted on elephants*. The same practice obtains in Tonquin, Siam, and Pegu. In these countries, the kings and nobles at public festivals, are always preceded and followed by numerous trains of elephants, pompously adorned with pieces of shining metal, and clothed with rich garments. Their tusks are ornamented with rings of gold and silver; their ears and cheeks are painted with various colours; they are crowned with garlands; and a number of small bells are fixed to different parts of their bodies. They delight in gaudy attire; for they are chearful and caressing in proportion to the number and splendour of their ornaments. The Asiatics, who were very anciently civilized, perceiving the sagacity and docility of

VOL. II.

X

the

* Thevenot, tom. 3. pag. 261.

the elephant, educated him in a systematic manner, and modified his dispositions according to their own manners, and the useful labours in which his strength and dexterity could be employed.

A domestic elephant performs more labour than could be accomplished by six horses; but he requires much care and a great deal of food. He is subject to be over-heated, and must be led to the water twice or thrice a-day. He easily learns to bathe himself. With his trunk he sucks up large quantities of water, carries it to his mouth, drinks part of it, and, by elevating his trunk, makes the remainder run over every part of his body. To give some idea of the labour he performs, and the docility of his dispositions, it is worthy of remark, that, in India, all the bales, sacks, and tuns, transported from one place to another, are carried by elephants. They carry burdens on their bodies, their necks, their tusks, and even in their mouths, by giving them the end of a rope, which they hold fast with their teeth. Uniting sagacity with strength, they never break or injure any thing committed to their charge. From the margins of the rivers, they put weighty bundles into
boats

boats without wetting them, lay them down gently, and arrange them where they ought to be placed. When the goods are disposed as their masters direct, they examine with their trunks whether the articles are properly stowed; and, if a cask or tun rolls, they go spontaneously in quest of stones to prop and render it firm.

In the elephant, the sense of smelling is acute, and he is passionately fond of odorous flowers, which he collects one by one, forms them into a nosegay, and, after gratifying his nose, conveys them to his mouth.

In India, the domestic elephants, to whom the use of water is as necessary as that of air, are allowed every possible convenience for bathing themselves. The animal goes into a river till the water reaches his belly. He then lies down on one side, fills his trunk several times, and dexterously throws the water on such parts as happen to be uncovered. The master, after cleaning and currying one side, desires the animal to turn to the other, which command he obeys with the greatest alacrity; and, when both sides have been properly cleaned, he comes out of the river,

and stands some time on the bank to dry himself. The elephant, though his mass be enormous, is an excellent swimmer; and, of course, he is of great use in the passage of rivers. When employed on occasions of this kind, he is often loaded with two pieces of cannon which admit three or four pound balls, beside great quantities of baggage and several men fixed to his ears and his tail. When thus heavily loaded, he spontaneously enters the river, and swims over with his trunk elevated in the air for the benefit of respiration. He is fond of wine and ardent spirits. By showing him a vessel filled with any of these liquors, and promising him it as the reward of his labours, he is induced to exert the greatest efforts, and to perform the most painful tasks. The elephant, as we are informed by M. de Buffon, quoted by the Count de Buffon, is employed in dragging artillery over mountains, and, on these occasions, his sagacity and docility are conspicuous. Horses or oxen, when yoked to a cannon, make all their exertions to pull it up a declivity. But the elephant pushes the breach forward with his front, and, at each effort, supports the carriage with his knee, which he places against
the

the wheel. He seems to understand what his *cornack*, or conductor, says to him. When his conductor wants him to perform any painful labour, he explains the nature of the operation, and gives the reasons which should induce him to obey. If the elephant shows a reluctance to the task, the cornack promises to give him wine, arrack, or any other article that he is fond of, and then the animal exerts his utmost efforts. But to break any promise made to him is extremely dangerous. Many cornacks have fallen victims to indiscretions of this kind. ‘At Dehan,’ says M. de Buffy, ‘an elephant, from revenge, killed his cornack. The man’s wife, who beheld the dreadful scene, took her two children, and threw them at the feet of the enraged animal, saying, *Since you have slain my husband, take my life also, as well as that of my children.* The elephant instantly stopped, relented, and, as if stung with remorse, took the eldest boy in its trunk, placed him on its neck, adopted him for its cornack, and would never allow any other person to mount it.’

From the members of the Royal Academy of Sciences, we learn some curious facts with regard

regard to the manners of the Versailles elephant. This elephant, they remark, seemed to know when it was mocked, and remembered the affront till it had an opportunity of revenge. A man deceived it, by pretending to throw some food into its mouth. The animal gave him such a blow with its trunk as knocked him down, and broke two of his ribs. A painter wanted to draw the animal in an unusual attitude, with its trunk elevated, and its mouth open. The painter's servant, to make it remain in this position, threw fruits into its mouth, but generally made only a faint of throwing them. This conduct enraged the elephant; and, as if it knew that the painter was the cause of this teasing impertinence, instead of attacking the servant, it eyed the master, and squirted at him from its trunk such a quantity of water as spoiled the paper on which he was drawing. This elephant commonly made less use of its strength than its address. It loosed, with great ease and coolness, the buckle of a large double leathern strap, with which its leg was fixed; and, as the servants had wrapped the buckle round with a small cord, and tied many knots upon it, the creature, with much deliberation, loosed

loosed the whole, without breaking either the strap or the cord.

It is remarked by le P. Vincent Marie, that the elephant, when in a domestic state, is highly esteemed for his gentleness, docility, and friendship to his governour. When destined to the immediate service of princes, he is sensible of his good fortune, and maintains a gravity of demeanour corresponding to the dignity of his situation. But if, on the contrary, less honourable labours are assigned to him, he grows melancholy, frets, and evidently discovers that he is humbled and depressed. He is fond of children, caresses them, and appears to discern the innocence of their manners. The Dutch voyagers relate*, that, by giving elephants what is agreeable to them, they are soon rendered perfectly tame and submissive. They are so sagacious, that they may be said to be destitute of the use of language only. They are proud and ambitious; and they are so grateful for good usage, that, as a mark of respect, they bow their heads in passing houses where they have been hospitably

* Voyage de la Compagnie des Indes de Hollande, tom. 1. pag. 413.

tably received. They allow themselves to be led and commanded by a child; but they love to be praised and caressed. When a wild elephant is taken, the hunters tie his feet, and one of them accosts and salutes him, makes apologies for binding him, protests that no injury is intended, tells him, that, in his former condition, he frequently wanted food, but that, henceforward, he shall be well treated, and that every promise shall be performed to him. This soothing harangue is no sooner finished than the elephant placidly follows the hunter*. From this fact, however, we must not conclude that the elephant understands language, but that, like the dog, he has a strong discerning faculty. He distinguishes esteem from contempt, friendship from hatred, and many other emotions which are expressed by human gestures and features. For this reason, the elephant is more easily tamed by mildness than by blows.

‘ I have frequently remarked,’ says Edward Terry†, ‘ that the elephant performs many actions which seem to proceed more from
‘ reason

* Voyage d'Orient. du P. Phillippe, pag. 366.

† Terry's Voyage to the East Indies, page 15.

‘ reason than from instinct. He does every
‘ thing that his master commands. If he wants
‘ to terrify any person, he runs upon him
‘ with every appearance of fury, and, when
‘ he comes near, stops short, without doing
‘ the person the smallest injury. When the
‘ master chooses to affront any man, he tells
‘ the elephant, who immediately collects wa-
‘ ter and mud with his trunk, and squirts it
‘ upon the object pointed out to him. The
‘ Mogul keeps some elephants who serve as
‘ executioners to criminals condemned to
‘ death. When the conductor orders one of
‘ these animals to despatch the poor criminals
‘ quickly, he tears them to pieces in a mo-
‘ ment with his feet; But, if desired to tor-
‘ ment them slowly, he breaks their bones one
‘ after another, and makes them suffer a pu-
‘ nishment as cruel as that of the wheel.’

Next to the elephant, the dog seems to be the most docile quadruped. A wild dog is a passionate, ferocious, and sanguinary animal. But, after he is reduced to a domestic state, these hostile dispositions are suppressed, and they are succeeded by a warm attachment, and a perpetual desire of pleasing. The perceptions and natural talents of the dog are acute.

When

When these are aided by instruction, the sagacity he discovers, and the actions he is taught to perform, often excite our wonder. Those animals which man has taken under his immediate protection are taught to perform artificial actions, or have their natural instincts improved, by three modes of instruction, punishment, reward, and imitation. More ductile in his nature than most other animals, the dog not only receives instruction with rapidity, but accommodates his behaviour and deportment to the manners and habits of those who command him. He assumes the very tone of the family in which he resides. Eager, at all times, to please his master, or his friends, he furiously repels beggars; because he probably, from their dress, conceives them to be either thieves, or competitors for food.

Though every dog, as well as every man, is naturally a hunter, the dexterity of both is highly improved by experience and instruction. The varieties of dogs, by frequent intermixtures with those of different climates, and perhaps with foxes and wolves, are so great, and their instincts are so much diversified, that, even though they produce with each other, we should be apt to regard them as different species.

species. What a difference between the natural dispositions of the shepherd's dog, the spaniel, and the grey-hound? The shepherd's dog, independently of all instruction, seems to be endowed by Nature with an innate attachment to the preservation of sheep and cattle. His docility is likewise so great, that he not only learns to understand the language and commands of the shepherd, and obeys them with faithfulness and alacrity, but, when at distances beyond the reach of his master's voice, he often stops, looks back, and recognises the approbation or disapprobation of the shepherd by the mere waving of his hand. He reigns at the head of a flock, and is better heard than the voice of his master. His vigilance and activity produce order, discipline, and safety. Sheep and cattle are peculiarly subjected to his management, whom he prudently conducts and protects, and never employs force against them, except for the preservation of peace and good order. But, when the flock committed to his charge is attacked by the fox, the wolf, or other rapacious animals, he makes a full display of his courage and sagacity. In situations of this kind, both his natural and acquired talents

talents are exerted. Three shepherds dogs are said to be a match for a bear, and four for a lion.

Every person knows the docility and sagacity of such dogs as are employed in conducting blind mendicants. Johannes Faber, as quoted by Mr. Ray, informs us, that he knew a blind beggar who was led through the streets of Rome by a middle sized dog. This dog, beside leading his master in such a manner as to protect him from all danger, learned to distinguish not only the streets, but the houses where his master was accustomed to receive alms twice or thrice a-week. Whenever the animal came to any of these streets, with which he was well acquainted, he would not leave it till a call had been made at every house where his master was usually successful in his petitions. When the beggar began to ask alms, the dog, being wearied, lay down to rest; but the master was no sooner served or refused, than the dog rose spontaneously, and, without either order or sign, proceeded to the other houses where the beggar generally received some gratuity. I observed, says he, not without pleasure and surprise, that, when a halfpenny was thrown from a window, such
was

was the sagacity and attention of this dog, that he went about in quest of it, lifted it from the ground with his mouth, and put it into his master's hat. Even when bread was thrown down, the animal would not taste it, unless he received a portion of it from the hand of his master. Without any other instruction than imitation, a mastiff, when accidentally shut out from a house which his master frequented, uniformly rung the bell for admittance. Dogs can be taught to go to market with money, to repair to a known butcher, and to carry home the meat in safety. They can be taught to dance to music, and to search for and find any thing that is lost*.

There is a dog at present belonging to a grocer in Edinburgh, who has for some time amused and astonished the people in the neighbourhood. A man who goes through the streets ringing a bell and selling penny pies, happened one day to treat this dog with a pye. The next time he heard the pyeman's bell, he ran to him with impetuosity, seized him by the coat, and would not suffer him to pass.

* For these, and many other instances of the sagacity and docility of the dog, the reader may consult *Synopsis Quadrupedum a Joanne Raio*, p. 6. &c.

pass. The pyeman, who understood what the animal wanted, showed him a penny, and pointed to his master, who stood in the street-door, and saw what was going on. The dog immediately supplicated his master by many humble gestures and looks. The master put a penny into the dog's mouth, which he instantly delivered to the pyeman, and received his pye. This traffick between the pyeman and the grocer's dog has been daily practised for months past, and still continues.

Dogs, horses, and even hogs, by rewards and punishments, and, I am afraid, often by cruelty, may be taught to perform actions, as we have frequently seen in public exhibitions, which are truly astonishing. But of these we must not enter into any detail.

With regard to the horse, the gentleness of his dispositions, and the docility of his temper, are so well and so universally known, that it is unnecessary to dwell long upon the subject. To give some idea of what instruction horses receive when in a domestic state, we shall mention some traits of their form and manners when under no restraints. In South America the horses have multiplied prodigiously,

digiously, and, in that thinly inhabited country, live in perfect freedom. They fly from the presence of man. They wander about in troops, and devour, in immense meadows, the productions of a perpetual spring. Wild horses are stronger, lighter, and more nervous, than the generality of those which are kept in a domestic state. They are by no means ferocious. Though superior in strength to most animals, they never make an attack. When assaulted, however, they either disdain the enemy, or strike him dead with their heels. They associate in troops from mutual attachment, and neither make war with other animals nor among themselves. As their appetites are moderate, and they have few objects to excite envy or discord, they live in perpetual peace. Their manners are gentle, and their tempers social. Their force and ardour are rendered conspicuous only by marks of emulation. They are anxious to be foremost in the course, to brave danger in crossing a river, or in leaping a ditch or precipice; and, it is said, that those horses which are most adventurous and expert in these natural exercises, are, when domesticated, the most generous, mild, and tractable.

Wild

Wild horses are taken notice of by several of the ancients. Herodotus mentions white wild horses on the banks of the Hypanis in Scythia. He likewise tells us, that, in the northern part of Thrace, beyond the Danube, there were wild horses covered all over with hair five inches in length. The wild horses in America are the offspring of domestic horses originally transported thither from Europe by the Spaniards. The author of the history of the Buccaneers* informs us, that troops of horses, sometimes consisting of 500, are frequently met with in the island of St. Domingo; that when they see a man, they all stop; and that one of their number approaches to a certain distance, blows through his nostrils, takes flight, and is instantly followed by the whole troop. He describes them as having gross heads and limbs, and long necks and ears. The inhabitants tame them with ease, and then train them to labour. In order to take them, gins of ropes are laid in the places where they are known to frequent. When caught by the neck, they soon strangle themselves, unless some person arrive in time to disentangle them.

They

* L'Hist. des Avantur. Flibustiers, tom. 1. pag. 110.

They are tied to trees by the body and limbs, and are left in that situation two days without victuals or drink. This treatment is generally sufficient to render them more tractable, and they soon become as gentle as if they had never been wild. Even when any of these horses, by accident, regain their liberty, they never resume their savage state, but know their masters, and allow themselves to be approached and retaken.

From these, and similar facts, it may be concluded, that the dispositions of horses are gentle, and that they are naturally disposed to associate with man. After they are tamed they never forsake the abodes of men. On the contrary, they are anxious to return to the stable. The sweets of habit seem to supply all they have lost by slavery. When fatigued, the mansion of repose is full of comfort. They smell it at considerable distances, can distinguish it in the midst of populous cities, and seem uniformly to prefer bondage to liberty. By some attention and address colts are first rendered tractable. When that point is gained, by different modes of management, the docility of the animal is improved, and they soon learn to perform with alacrity the

various labours assigned to them. The domestication of the horse is perhaps the noblest acquisition from the animal world which has ever been made by the genius, the art, and the industry of man. He is taught to partake of the dangers and fatigues of war, and seems to enjoy the glory of victory. He encounters death with ardour and with magnanimity. He delights in the tumult of arms, and attacks the enemy with resolution and alacrity. It is not in perils and conflicts alone that the horse co-operates with the dispositions of his master. He even seems to participate of human pleasures and amusements. He delights in the chace and the tournament, and his eyes sparkle with emulation in the course. Though bold and intrepid, however, he does not allow himself to be hurried on by a furious ardour. On proper occasions he represses his movements, and knows how to check the natural fire of his temper. He not only yields to the hand, but seems to consult the inclination of his rider. Always obedient to the impressions he receives, he flies or stops, and regulates his motions solely by the will of his master.

Mr.

Mr. Ray, who wrote about the end of last century, informs us, that he had seen a horse who danced to music, who, at the command of his master, affected to be lame, who simulated death, lay motionless with his limbs extended, and allowed himself to be dragged about, till some words were pronounced, when he instantly sprung up on his feet*. Facts of this kind would scarcely receive credit, if every person were not now acquainted with the wonderful docility of the horses educated by Astley, and other public exhibitors of horsemanship. In exhibitions of this kind, the docility and prompt obedience of the animals deserve more admiration than the dexterous feats of the men.

Animals of the ox-kind, in a domestic state, are dull and phlegmatic. Their sensibility and talents seem to be very limited. But we should not pronounce rashly concerning the genius and powers of animals in a country where their education is totally neglected. In all the southern provinces of Africa and Asia, there are many wild bisons, or bunched oxen,

Y 2 which

* Raii Synopsis Animalium Quadrupedum, pag. 10.

which are taken when young and tamed. They are soon taught to submit, without resistance, to all kinds of domestic labour. They become so tractable, that they are managed with as much ease as our horses. The voice of their master is alone sufficient to make them obey, and to direct their course. They are shod, curried, caressed, and supplied abundantly with the best food. When managed in this manner, these animals appear to be different creatures from our oxen. The oxen of the Hottentots are favourite domestics, companions in amusements, assistants in all laborious exercises, and participate the habitation, the bed, and the table of their masters. As their nature is improved by the gentleness of their education, by the kind treatment they receive, and the perpetual attention bestowed on them, they acquire sensibility and intelligence, and perform actions which one would not expect from them. The Hottentots train their oxen to war. In all their armies there are considerable troops of these oxen, which are easily governed, and are let loose by the chief when a proper opportunity occurs. They instantly dart with impetuosity upon the enemy. They strike with their horns, kick,

kick, overturn, and trample under their feet every thing that opposes their fury. They run ferociously into the ranks, which they soon put into the utmost disorder, and thus pave the way for an easy victory to their masters*. These oxen are likewise instructed to guard the flocks, which they conduct with dexterity, and defend them from the attacks of strangers, and of rapacious animals. They are taught to distinguish friends from enemies, to understand signals, and to obey the commands of their master. When pasturing, at the smallest signal from the keeper, they bring back and collect the wandering animals. They attack all strangers with fury, which renders them a great security against robbers. These *brackeleys*, as they are called, know every inhabitant of the kraal, and discover the same marks of respect for all the men, women, and children, as a dog does for those who live in his master's house. These people may, therefore, approach their cattle with the greatest safety. But, if a stranger, and particularly an European, should use the same freedom, without being accompanied with one of

* Voyage de Cap, par Kolbe, tom. 1. pag. 160.

of the Hottentots, his life would be in imminent danger*.

Notwithstanding the many surprising actions which different quadrupeds may be taught to perform, none of them, though their organs are much more perfect than those of birds, have ever been able to pronounce articulate sounds. But many birds, without much instruction, learn to pronounce words, and even sentences. In parrots, the distinguishing accuracy of their ear, the acuteness of their attention, and their strong instinctive propensity to imitate sounds of every kind, have justly procured them universal admiration. When in a state of domestication, the parrot learns to pronounce the common street-calls, beside many words and phrases occasionally employed by the family in which he resides. Though the limitation of his mental powers does not permit him to learn any extent of language, or the proper use and meaning of words, he not unfrequently discovers the association between the object and the sound. A woman every morning passed the window, where a parrot's cage was fixed, calling salt. The
parrot

* Voyage de Cap, par Kolbe, pag. 307.

parrot soon learned to imitate the call. But, before any sound could be heard, he no sooner cast his eye upon the woman than he uttered her usual call. In this, and many other similar cases, the objects and the sounds are evidently connected in the mind of the animal. How far these associations might be carried by a patient and persevering education, it is difficult to determine. In this manner, however, parrots might be taught a considerable vocabulary of substantive nouns, or the proper names of common objects. But his intellect, it is more than probable, would never reach the use of the verb, and other parts of speech.

Beside parrots, jays, &c. who learn to pronounce articulate sounds, there is another race of birds whose docility deserves to be mentioned. Singing birds, those lively and spirited little animals, attempt not to articulate. But their musical ears are as delicate and discerning as their voices are melodious and delightful. The vivacity, the extent of voice, and the imitative powers of these beautiful creatures, have at all times excited the attention and conciliated the affections of mankind. When domesticated, these birds, beside their natural notes,

soon

soon acquire the faculty of singing considerable parts of artificial tunes. These imitations are effects of natural instinct. But, in exhibitions, I have seen linnets simulate death, and remain perfectly tranquil and unmoved, when small cannons were fired within an inch of their bodies, from a wooden fort. These little creatures have even been taught to lay hold of a match and fire the cannons themselves.

The docility and sagacity of animals have always been considered as wonderful. But this wonder is partly the effect of inattention; for, though man is unquestionably the chief of the animal creation, the other animals, according to the number of instincts, or, which amounts to the same thing, according to the mental powers with which Nature has endowed them, comparatively approach to or recede from the sagacity and genius of the human species. The whole is a graduated scale of intelligence. A philosopher should, therefore, contemplate and admire the whole, but should never be surprised at any partial exhibitions of the general scene of intellect and animation.

We shall conclude this subject with a few remarks concerning the changes produced in animals by DOMESTICATION.

Climate

Climate and food are the chief causes which produce changes in the magnitude, figure, colour, and constitution, of wild animals. But, beside these causes, there are others which have an influence upon animals when reduced to a domestic or unnatural state. When at perfect liberty, animals seem to have selected those particular zones or regions of the globe which are most consonant to the nature and constitution of each particular tribe. There they spontaneously remain, and never, like man, disperse themselves over the whole surface of the earth. But, when obliged by man, or by any great revolution of Nature, to abandon their native soil, they undergo changes so great, that, to recognise and distinguish them, recourse must be had to the most accurate examination. If we add to climate and food, those natural causes of alteration in free animals, the empire of man over such of them as he has reduced to servitude, the degree to which tyranny degrades and disfigures Nature will appear to be greatly augmented. The mouflon, the stock from which our domestic sheep have derived their origin, is comparatively a large animal. He is as fleet as a stag, armed with horns and strong hoofs, and covered with coarse hair.

With

With these natural advantages, he dreads neither the inclemency of the sky, nor the voracity of the wolf. By the swiftness of his course, he not only escapes from his enemies, but he is enabled to resist them by the strength of his body and the solidity of his arms. How different is this animal from our domestic sheep, who are timid, weak, and unable to defend themselves? Without the protection of man, the whole race would soon be extirpated by rapacious animals and by winter-storms. In the warmest climates of Africa and of Asia, the mouflon, who is the common parent of the sheep, appears to be less degenerated than in any other region. Though reduced to a domestic state, he has preserved his stature and his hair; but the size of his horns is diminished. The sheep of Barbary, Egypt, Arabia, Persia, &c. have undergone greater changes; and, in proportion as they approach toward either pole, they diminish in size, in strength, in swiftness, and in courage. In relation to man, they are improved in some articles, and vitiated in others. Their coarse hair is converted into fine wool. But, with regard to Nature, improvement and degeneration amount to the same thing; for
both

both imply an alteration of the original constitution.

The ox is more influenced by nourishment than any other domestic animal. In countries where the pasture is luxuriant, the oxen acquire a prodigious size. To the oxen of *Æthiopia* and some provinces of *Asia*, the ancients gave the appellation of *Bull-Elephants*, because, in these regions, they approach to the magnitude of the elephant. This effect is chiefly produced by the abundance of rich and succulent herbage. The Highlands of Scotland, and indeed every high and northern country, afford striking examples of the influence of food upon the magnitude of cattle. The oxen, as well as the horses, in the more northern parts of Scotland, are extremely diminutive; but, when transported to richer pasture, their size is augmented, and the qualities of their flesh are improved. The climate has likewise a considerable influence on the nature of the ox. In the northern regions of both continents, he is covered with long soft hair. He has likewise a large bunch on his shoulders; and this deformity is common to the oxen of *Asia*, *Africa*, and *America*. Those of Europe have no bunch. The European oxen, however, seem
to

to be the primitive race, to which the bunched kind ascend, by intermixture, in the second or third generation. The difference in their size is remarkably great. The small zebu, or bunched ox of Arabia, is not one-tenth part of the magnitude of the Æthiopian bull-elephant.

The influence of food upon the dog-kind seems not to be great. In all his variations and degredations, he appears to follow the differences of climate. In the warmest climates, he is naked; in the northern regions, he is covered with a coarse thick hair, and he is adorned with a fine silky robe in Spain and Syria, where the mild temperature of the air converts the hair of most quadrupeds into a kind of silk. Beside these external variations produced by climate, the dog undergoes other changes, which proceed from his situation, his captivity, and the nature of the intercourse he holds with man. His size is augmented or diminished by obliging the smaller kinds to unite together, and by observing the same conduct with the larger individuals. The shortening of the tail and ears proceeds also from the hand of man. Dogs who have had their ears and tails cut for a few generations, transmit these defects, in a certain degree, to their descendants. Pendulous

lous ears, the most certain mark of domestic servitude and of fear, are almost universal. Of many races of dogs, a few only have retained the primitive state of their ears. Erect ears are now confined to the wolf-dog, the shepherd's dog, and the dog of the North.

The colour of animals is greatly variegated by domestication. The dog, the ox, the sheep, the goat, the horse, have assumed all kinds of colours, and even mixtures of colours, in the same individuals. The hog has changed from black to white; and white, without the intermixture of spots, is generally accompanied with essential imperfections. Men who are remarkably fair, and whose hair is white, have generally a defect in their hearing, and, at the same time, weak and red eyes. Quadrupeds which are entirely white have likewise red eyes and a dulness of hearing. The variations from the original colour are most remarkable in our domestic fowls. In a brood of chickens, though the eggs be laid by the same hen, and though the female be impregnated by the same male, not one of them has the same colours with another.

Domestication not only changes the external appearances of animals, but alters or modifies
their

their natural dispositions. The dog, for example, when in a state of liberty, is a rapacious quadruped, and hunts and devours the weaker species: But, after he has submitted to the dominion of man, he relinquishes his natural ferocity, and is converted into a mean, servile, patient, and parasitical slave.

CHAP.

CHAPTER XVIII.

Of the Characters of Animals.

ON this subject it never was intended to paint the characters of every species, even of the larger animals. The reader will easily recollect, that, in many parts of this work, much has already been said with regard to the tempers, dispositions, and manners, of a great number of animals. These we shall not repeat, but proceed to some general remarks.

On every animal Nature has imprinted a certain *character*, which is indelibly fixed, and distinguishes the species. This character we discover by the actions, the air, the countenance, the movements, and the whole external appearance. The courage of the lion, the ferocity of the tiger, the voraciousness of the wolf, the pride of the courser, the dullness and indolence of the ass, the cunning and address of the fox, the affection and docility of the dog, the subtlety and selfishness of the cat,
the

the mildness of the sheep, the timidity of the hare, the vivacity of the squirrel, are proper examples. These characters, when under the influence of domestication, may be modified by education, of which rewards and punishments are the chief instruments employed. But the original character, impressed by the hand of Nature, is never fully obliterated. Those animals which seem to have been destined by Nature to live in perpetual slavery under the dominion of man, have the mildest and most gentle dispositions. It is pleasant, but, at the same time, somewhat contemptible, to see a troop of oxen guided by the whip of a child.

In the human species, the variety of tempers, affections, aversions, and studies, is indispensibly necessary for supporting the social state, and carrying on the general business of life. Some minds are formed for study and deep research, and others for action, courage, and the exertion of bodily powers. The same variety in the dispositions and manners of the different tribes of animals is equally necessary for peopling the earth, and for supplying the reciprocal exigencies of its inhabitants.

Beside

Beside the general specific characters of animals, individual characters, especially among the human race, are strongly marked, and greatly variegated. In every government, and particularly in commercial states, human characters, independently of the original bias, or genius, stamped by Nature on individual minds, are often so disguised by a thousand artifices, that it requires not only time, but frequent interesting scenes, before a man can discover the real character even of an intimate companion. Many men associate together in the most harmonious manner, and show every symptom of friendship and attachment; but, when any of them happens to be distressed, and to require aid, all this apparent friendship instantly vanishes, the aspect of the countenance, instead of exhibiting sympathy and cordiality, is converted into a cold reserve, and the unfortunate former companion is first shunned, and then deserted. This picture of human nature, we are sorry to remark, is too general; but, thank Heaven, it is not universal; for there always were, and still are, men of noble and generous minds, who willingly sacrifice part of their own interest to that of their friends.

With regard to the characters of quadrupeds, beside the specific dispositions which distinguish the different kinds, each individual possesses a peculiar character by which it may be discriminated from any other. These individual characters may be discovered not only by the aspect, but by the actions of animals. Some dogs, even of the same race, are surly, churlish, and revengeful. Others are gay, frolicsome, and friendly. The countenances of men, which always indicate some part of their original and genuine character, are as various as their numbers. Though less subject to general observation, Nature has marked the countenances of every animal, even down to the insect tribes, with some characteristic strokes, which enable them to distinguish one another, and even to contract particular attachments. To us, the small birds, such as sparrows and linnets, appear to be so perfectly similar, that, though we had an opportunity of seeing great numbers of them collected in one place, it would require much time and attention to be enabled to make individual distinctions. After they have brought up their young, they associate promiscuously in flocks; but, when the genial spring

spring arrives, a different scene is exhibited. The flocks disappear. Each male has selected, courted, and retired with a female to build a nest, to hatch eggs, and to nourish and support their young. If Nature had not stamped upon every individual a peculiar mark, it would be impossible that the immense multitudes who pair, or join in matrimony, should be capable of distinguishing and adhering faithfully to one another. A shepherd, who has been long accustomed to superintend a numerous flock, knows, by the countenances, and other natural or accidental marks, every individual. I knew a shepherd, who not only distinguished every individual of above two hundred sheep, but gave to each a particular name.

The characters of quadrupeds, and even of some birds, are indicated by obscure resemblances between the lineaments of their faces, and those of men of different features and dispositions. Some men, in the general expression of their countenances, resemble goats, others sheep, others oxen, others swine, others lions, others dogs, others foxes, others owls, others hawks. Even in particular races of the same species, similarities of this kind may be

Z 2

traced.

traced. I know some men who resemble terriers, others greyhounds, others spaniels, others the shepherd's dog, others the lap-dog, &c. Some of these resemblances may be regarded as fanciful, and perhaps they frequently are. But, in general, when the resemblance to a particular animal is strongly marked in a human countenance, the dispositions of the man have a striking affinity to those of the animal. Men who resemble the fox, are uniformly cunning and deceitful. Those who resemble the ox are dull, stupid, and phlegmatic. Those who resemble the lion are bold, open, generous, and witty. Those who resemble the cat are circumspect, designing, and avaricious. Those resemble the greyhound are vigilant, active, and smart. Those who resemble the lap-dog are vain, presumptuous, petulant, and lascivious. Those who resemble the sow are disgusting both in their appearance and in their dispositions. Those who resemble a cross-made horse are cruel, unfeeling, and highly selfish. Those who resemble the spaniel, of whom the examples are numerous, are fawning, mean, and parasitical. Those who resemble the sheep are dull, timid, and inoffensive. Those who resemble the

the goat are fanciful, obstinate, and libidinous. Those who resemble a fine horse are intrepid, generous, tractable, and good humoured. Those who resemble a hawk are quick, desultory, and ingenious. Those who resemble the owl are dark, designing, and treacherous. Those who resemble the bee are active, ignorant, and industrious. It is needless to multiply examples. Every man's recollection and observation will furnish him with numberless coincidences between the similarities in structure and features to particular animals, and the form, dispositions, and manners of the men who possess them.

Comparisons have been instituted, and analogies traced, between the structure, aspect, and dispositions, of some quadrupeds and those of certain birds, which show a uniformity in the general plan of Nature. Among birds, as well as quadrupeds, some species are carnivorous, and others feed upon fruits, grain, and various kinds of herbage. The eagle, which is a noble and a generous bird, represents the lion. The vulture, which is cruel and insatiable, represents the tiger. The kite, the buzzard, and the raven, who live chiefly on offals and carrion, represent the
hyaena,

hyaena, the wolf, and the jackal. The falcon, the sparrow-hawk, and other birds employed in hunting, represent the dog, the fox, the lynx, &c. The owl, who searches for her prey in the night, represents the cat. The heron and the cormorant, who feed upon fishes, represent the beaver and the otter. Peacocks, hens, and all other birds which have a crop, or craw, represent oxen, sheep, goats, and other ruminating animals.

CHAP.

CHAPTER XIX.

Of the Principle of Imitation.

IMITATION necessarily implies some degree of intelligence. All animals, particularly those of the more perfect kinds, are endowed with the principle of imitation. The consequence is obvious, that all animals possess a certain portion of intellectual power. In man, the principle of imitation appears at a very early period of his existence. In the more advanced stages of life, this principle is so interwoven with other motives of acting and thinking, that it is difficult to distinguish it as a separate instinct, and equally difficult to conquer the habits and prejudices to which it has given rise. The less a man has cultivated his rational faculties, the more powerful is the principle of imitation over his actions and his habits of thinking. Most women, of course, are more influenced by the behaviour, the fashions, and the opinions

nions of those with whom they associate than men. From this almost irresistible instinct, we should learn the extreme danger of frequenting the company of the dissolute and unprincipled; for bad habits are soon acquired, but very difficult to conquer. It is a comfortable circumstance, however, that if men, especially when young, are fortunate enough to fall in with the society of the virtuous and intelligent, the principle of imitation, so benevolent is Nature, acts with redoubled force. If we attend to our own feelings, we must acknowledge, that, in the acquisition of bad habits, there is an evident force upon our natural inclinations, but that, in virtuous associations, the mind acquiesces with pleasure, and feels no restraint in complying with the examples it perceives, nor in acquiring the correspondent habits. We are prone to evil; but, when not corrupted by improper imitations, Nature has made us much more prone to good.

Artificial language, which we learn entirely by imitation, distinguishes us, more than any other circumstance, from the brute creation. The proper use of it likewise forms the
chief

chief difference between one man and another; for, by language, one man discovers a superiority of knowledge and of genius, while others express by it nothing but borrowed or confused ideas. In an idiot, or in a parrot, it marks only the most abject degree of stupidity. It shows the incapacity of either to produce a regular chain of thinking, though both of them be endowed with organs capable of expressing what passes within their minds. Men whose senses are delicate, and whose minds are easily affected, make the best actors, and the best mimics. Children, accordingly, are extremely alert in imitating the actions, the gestures, and the manners of those with whom they associate. They are dexterous in perceiving ridiculous figures and representations, which they imitate with ease and propriety. Hence we perceive, in the education of children, the infinite importance of regulating the principle of imitation.

The education of the inferior animals, though short, is always successful. By imitation, they soon acquire all the knowledge possessed by their parents. They not only derive experience from their own feelings, but,

but, by imitation, they learn and employ the experience of others. Young animals model their actions entirely upon those of the old. They see their seniors approach or fly when they perceive particular objects, hear particular sounds, or smell certain odours. At first, they approach or fly without any other determining principle but that of imitation. Afterwards, they approach or fly spontaneously, because they have then acquired the habit of approaching or flying, whenever they feel the same or similar sensations. Many instincts, as terror upon hearing particular sounds, the appearance of natural enemies, the selection of food, &c. seem to be partly the effects of imitation. It is remarked by Ulloa, that, in the year 1743, the dogs in Juan Fernandes had lost the faculty of barking. When associated with other dogs, it was with great difficulty that they again learned, by imitation, to bark. The cause of these dogs losing the expression of their usual language in a domestic state, it is not easy to investigate. Perhaps, by the aid of experience, and their own sagacity, they discovered that barking warned their prey to escape from danger. The jackals, however, who are considered as belonging to the dog-kind, not only

only hunt in packs, but, during the chase, make a loud and a hideous noise. Mr. White, in his Natural History of Selborne, a work which contains much information, and discovers a good and benevolent heart in the author, informs us, that he had an opportunity of seeing two dogs, a male and a female, which had been brought from Canton in China. These dogs, which, in China, are fattened for eating, are about the size of an ordinary spaniel, and are of a pale yellow colour. ‘ When taken out into a field,’ he remarks, ‘ the bitch showed some disposition for hunting, and dwelt on the scent of a covey of partridges till she sprung them, giving her tongue all the time. The dogs in South America are dumb; but these bark much in a short thick manner like foxes; and have a surly savage demeanour, like their ancestors, which are not domesticated, but bred up in flies, where they are fed for the table with rice-meal, and other farinaceous food. These dogs, having been taken on board as soon as weaned, could not have learned much from their dam; yet they did not relish flesh when they came to England. In the islands of the Pacific Ocean, the dogs are bred upon vegetables,

‘getables, and would not eat flesh when offered them by our circumnavigators.’

From facts of this kind, of which a great number might be mentioned, the following observations naturally arise. These Chinese dogs, though descended, probably for many generations, from a race of ancestors who never had the least experience or education in hunting, preserved their original instinct of scenting and pursuing game. The dog is a grossly carnivorous animal; for he prefers carrion to any other kind of nourishment; yet the Chinese dogs discovered no particular relish for the flesh of animals. Thus it appears, that, by habits, acquired, not by the individual, but by a train of ancestors, both the taste and the constitution of animals may be greatly altered. From the same facts, however, it is equally evident, that Nature can never be entirely conquered. The moment the Chinese dogs first saw a field, they both scented and hunted game. Imitation and habit seem to have greater effects upon the mode of living, feeding, and the corporeal fabric, than upon the original instincts of the mind. These

These dogs, even when they came to England after a long voyage, had not acquired the habit of greedily devouring, like other dogs, either fresh meat or carrion; but, on the first opportunity afforded to them, they discovered an inclination to hunt.

CHAP-

CHAPTER XX.

Of the Migration of Animals.

THE Hon. Daines Barrington, in his *Essay on the Periodical Appearing and Disappearing of certain Birds, at different times of the year**, has, by many ingenious arguments, as well as curious facts, rendered it extremely probable, that no birds, however strong and swift in their flight, can possibly fly over such large tracts of the ocean as has been commonly supposed. He admits partial migrations or *flittings*, as he calls them, though he does not attempt to ascertain the distances of these flittings. With regard to the swallows, of which there are several species in Britain, some naturalists, of whom the Hon. Daines Barrington is one, are inclined to think that they do not leave this island at the end of autumn, but that they lie in a torpid state till the beginning of summer in the banks of rivers, the hollows of decayed trees,

* Phil. Transact. vol. 62. pag. 265, &c.

trees, the recesses of old buildings, the holes of sand-banks, and in similar situations. That swallows, in the winter months, have sometimes, though very rarely, been found in a torpid state, is unquestionably true. Neither is the inference, that, if any of them can survive the winter in that state, the whole of them may subsist, during the cold season, in the same condition, in the smallest degree unnatural. Still, however, the numbers of swallows which appear in this island, as well as in all parts of Europe, during the summer months, are so very considerable, that, if the great body of them did not migrate to some other climate, they should be much more frequently found in a torpid state. On the contrary, when a few of them are discovered in that state, it is regarded as a wonder even by the country people, who have the greatest opportunities of stumbling upon facts of this kind. When, accordingly, a few swallows or martins are found torpid in winter, and have been revived by a gentle heat, the fact, and few such facts there are, is carefully recorded as singular in all the periodical publications of Europe.

Mr.

Mr. Pennant informs us, from undoubted authority, that some quails, and other birds which are generally supposed to leave this island in winter, retire to the sea-coasts, and pick up their food among the seaweeds*.

‘ Quails,’ Mr. Pennant remarks. ‘ are birds
 ‘ of passage; some entirely quitting our island,
 ‘ others shifting their quarters. A gentleman,
 ‘ to whom this work lies under great obligations,
 ‘ has assured us, that these birds migrate out of the neighbouring inland counties,
 ‘ into the hundreds of Essex in October,
 ‘ and continue there all the winter: If frost
 ‘ or snow drive them out of the stubble-fields
 ‘ and marshes, they retreat to the sea-side,
 ‘ shelter themselves among the weeds, and live
 ‘ upon what they can pick up from the algae,
 ‘ &c. between high and low water mark. Our
 ‘ friend remarks, that the time of their appearance in Essex coincides with that of their
 ‘ leaving the inland counties†.’

A quail, it must be allowed, seems to be very much unqualified for a long migration; for its tail is short, the bird never rises more than

* Brit. Zool Vol. 1. pag. 210. 2d edit. 8vo.

† Pennant, *ibid.*

than twenty or thirty feet from the ground, and it seldom flies above three hundred yards at a time. Belon, however, an author of great sagacity and credit, tells us, that, in his passage from Rhodes to Alexandria, many quails, flying from north to south, were taken in his ship. From this circumstance, he remarks, 'I am persuaded that they shift places; for formerly, when I sailed out of the Isle of Zant to Morea, or Negropont, in the spring, I observed quails flying the contrary way, at which time, also, a great many were taken in our ship.' This traverse they might be enabled to accomplish by passing from one island to another in the Mediterranean.

Instances of swallows and some other birds alighting on the masts and cordage of vessels, at considerable distances from any shore, are not so numerous as might be expected. Neither have they been often observed flying over seas in great flocks. Mr. Peter Collinson, in a letter printed in the Philosophical Transactions, says, 'that Sir Charles Wager had frequently informed him, that in one of his voyages home in the spring, as he came into soundings in our channel, a great flock of

‘ swallows almost covered his rigging ; that
‘ they were nearly spent and famished, and
‘ were only feathers and bones ; but, being
‘ recruited by a night’s rest, they took their
‘ flight in the morning.’

M. Adanson, in his voyage, informs us, that, about fifty leagues from the coast of Senegal, four swallows settled upon the ship, on the sixth day of October ; that these birds were taken ; and that he knew them to be the true swallow of Europe, which he conjectures were then returning to the coast of Africa. The Hon. Daines Barrington, with more probability, supposes that these swallows, instead of being on their passage from Europe, were only flitting from the Cape de Verde islands to the continent of Africa, a much shorter flight, but to which they seemed to be unequal, as they were obliged, from fatigue, to light upon the ship, and fall into the hands of the sailors.

Swallows, Mr. Kalm remarks, appear in the Jerseys about the beginning of April. They are, on their first arrival, wet, because they have just emerged from the sea or lakes, at the bottom of which they had remained in a torpid state during the whole winter. But
Mr.

Mr. Kalm, who wishes to support the torpidity of swallows during the winter, likewise informs us, that he himself met with them at sea, nine hundred and twenty miles from any land*.

These, and similar facts, the Hon. Daines Barrington endeavours to explain, by supposing that birds discovered in such situations, instead of attempting to cross large branches of the ocean, have been forcibly driven from some coast by storms, and that they would naturally perch upon the first vessel which came within their view.

In Britain, five species of swallows appear in summer and disappear in winter. 1. The house-swallow makes its appearance about twenty days earlier than the martin, or any other of the swallow tribe. They are often seen about the 13th day of April. They disappear about the end of September. A few days previous to their departure, they assemble in great flocks on the tops of houses, churches, and trees, from whence they are supposed to take their flight. This unusual and temporary association of numbers indicates the im-

A a 2

pulse

* Voy. tom. 1. pag. 24.

pulse of some common instinct by which each individual is actuated. The house swallow is easily distinguished from the other species by the superior forkiness of its tail, and by a red spot on the forehead, and under the chin. This species builds in chimneys, and makes its nest of clay, but leaves the top quite open. 2. The martin is inferior in size to the former, and its tail is much less forked. The martins appear in Britain soon after the house-swallow. They build under the eaves of houses: The nest is composed of the same materials as those of the house-swallow: but it is covered above, and a small hole only is left in the side for the ingress and egress of the birds. The martins totally disappear about the beginning of October. 3. The sand-martin, or bank-martin, is by much the smallest of the swallow-kind that visit Britain. The sand-martins arrive very soon after the house-swallow, and disappear about Michaelmas. They dig considerable holes in sand-pits and in the banks of rivers, where they build their nests, which consist not of mud, like those of the former species, but of grasses and feathers laid together in a very slovenly manner. It is worthy of remark, that these birds do not employ
the

the cavities they dig in summer for winter quarters; since sand-banks, so perforated, have been carefully searched in the winter, and nothing was found but empty nests*. 4. The swift, or black martin of Willoughby, is the largest of our swallows, and is the latest of arriving in this country; for the swifts are seldom seen till the beginning of May, and commonly appear, not in flocks, but in pairs. Swifts, like the sand-martins, carry on the business of incubation in the dark. They build in the cranies of castles, towers, and steeples. Straw and feathers are the materials they use. They disappear very early; for they are almost never seen after the middle of August. 5. The goatsucker, which belongs to the swallow tribe, is likewise a bird of passage. Like the other swallows, it feeds upon winged insects. But, instead of pursuing its prey during the day, it flies only in the night, and seizes moths, and other nocturnal insects. From this circumstance, it has not improperly received the appellation of the *nocturnal swallow*. The goat-sucker stays only a short time in Britain. It appears not till about the

* White's Natural History of Selborne, page 177.

end of May, and retires in the middle of August. It lays its eggs, which are commonly two, and sometimes three, on the bare ground.

To give catalogues of the numerous birds of passage which frequent this island, as well as other countries, and to mark the times of their arrival and departure, would be deviating entirely from our plan. For circumstances of this kind, the curious may consult Catesby, Klein, *Linnaei Amonitates Academicæ*, White, &c. But, as the periodical appearance and disappearance of the swallow-tribe have given rise to different theories and opinions, we shall briefly relate those opinions, and conclude with some remarks on migration in general.

Herodotus and Prosper Alpinus mention one species of swallow which resides in Egypt during the whole year*; and Mr. Loten, late governour of Ceylon, assured Mr. Pennant, that those of Java never remove. If these be excepted, all the other known kinds retreat or migrate periodically. Swallows migrate from almost every climate. They remove
from

* Prosp. Alp. tom. 1. pag. 198.

from Norway*, from North America†, from Kamschatka‡, from the temperate parts of Europe, from Aleppo§, and from Jamaica||.

Concerning the periodical appearance and disappearance of swallows, there are three opinions adopted by different naturalists. The first and most probable is, that they remove from climate to climate at those particular seasons when winged insects, their natural food, fails in one country or district, and abounds in another, where they likewise find a temperature of air better suited to their constitutions. In support of this opinion, we have the testimony, as formerly mentioned, of Sir Charles Wager, of M. Adanson, and of many navigators. It is equally true, however, that some species of swallows have been occasionally found in a torpid state during winter. Mr. Collinson gives the evidence of three gentlemen who were eye-witnesses to a number of sand-martins being drawn out of a cliff on the Rhine

* Pontopp. Hist. Norw. ii. 98.

† Catesby's Carol. v. 1. pag. 51. App. 8.

‡ Hist. Kamschatka, page 162.

§ Russel's Alep. page 70.

|| Phil. Trans. N^o 36.

Rhine in the month of March 1762*, the Hon. Daines Barrington, in the year 1768, communicated to Mr. Pennant, on the authority of the late Lord Belhaven, the following fact: ‘ That numbers of swallows have been
 ‘ found in old dry walls; and in sand-hills,
 ‘ near his Lordship’s seat in East Lothian;
 ‘ not once only, but from year to year; and
 ‘ that, when they were exposed to the warmth
 ‘ of a fire, they revived†.’ These, and other facts of the same kind, seem to be uncontrovertible; and Mr. Pennant infers from them, that, ‘ we must divide our belief relating to
 ‘ these two so different opinions, and conclude,
 ‘ that one part of the swallow tribe migrate,
 ‘ and that others have their winter-quarters
 ‘ near home‡.’ But we should rather incline to think, with those naturalists who suppose that the torpid swallows which are occasionally, though very rarely, discovered in the winter season, have been obliged to remain behind, because they were too young, weak, diseased, or superannuated, to undertake a long and fatiguing flight. Still, however, that the torpidity

* Philosoph. Transact. vol. 53. page 101. art. 24.

† Pennant’s British Zoology, vol. 2. page 250, 8vo edit.

‡ Ibid. 251.

dity of the feathered tribes should be solely confined to the swallows, is a very singular fact in the history of Nature. Among quadrupeds, there are many species who lie in a dormant or torpid state during winter. But, if the swallow be excepted, not a single species of birds, notwithstanding the great numbers which, at stated times, appear and disappear in every corner of the globe, has ever been discovered in that state. This circumstance alone, though we cannot yet ascertain the precise places to which different species of birds of passage resort, is a most convincing proof of migration in general.

It has been asserted, and even believed, by some naturalists, that swallow pass the winter immersed under the ice, at the bottom of lakes, or beneath the waters of the sea. Olaus Magnus, Archbishop of Upsal, seems to have been the first who adopted this opinion. He informs us, that swallows are found in great clusters at the bottoms of the northern lakes, with mouth to mouth, wing to wing, foot to foot, and that in autumn they creep down the reeds to their subterraneous retreats*. ' That
the

* Derham's Phys.-Theol. pag. 349.

‘ the good Archbishop,’ Mr. Pennant archly remarks, ‘ did not want credulity in other instances, appears from this, that, after having stocked the bottoms of the lakes with birds, he stores the clouds with mice, which sometimes fall in plentiful showers on Norway and the neighbouring countries!’ Klein has endeavoured to support the notion that swallows lie under water during the winter, and gives the following account of their manner of retiring, which he collected from some countrymen: They asserted, he tells us, that the swallows sometimes assembled in numbers on a reed till it broke and sunk them to the bottom: That their immersion was preceded by a kind of dirge, which lasted more than a quarter of an hour: That others united, laid hold of a straw with their bills, and plunged down in society: That others, by clinging together with their feet, formed a large mass, and in this manner committed themselves to the deep*.

Two reasons seem to render this supposed submerision of swallows impossible. In the first place, no land-animal can exist so long without

* Klein Prod. Hist. Avium, pag. 205.—206.

without some degree of respiration. The otter, the seal, and water-fowls of all kinds, when confined under the ice, or entangled in nets, soon perish; yet it is well known, that animals of this kind can remain much longer under water than those who are destitute of that peculiar structure of the heart which is necessary for any considerable residence beneath that penetrating element. Mr. John Hunter, in a letter to Mr. Pennant, informs us, ‘ That he had dissected many swallows, but found nothing in them different from other birds as to the organs of respiration: That all those animals which he had dissected of the class that sleep during winter, such as lizards, frogs, &c. had a very different conformation as to those organs: That all those animals, he believes, do breathe in their torpid state; and, as far as his experience reaches, he knows they do; and that, therefore, he esteems it a very wild opinion, that terrestrial animals can remain any long time under water without drowning.’ Another argument against their submersion arises from the specific gravity of the animals themselves. Of all birds, the swallow tribes are perhaps the lightest. Their plumage, and the comparative

rative smallness of their weight, indicate that Nature destined them to be almost perpetually on the wing in quest of food. From this specific lightness, the submersion of swallows, and their continuing for months under water, amount to a physical impossibility. Even water-fowls, when they wish to dive, are obliged to rise and plunge with considerable exertion, in order to overcome the resistance of the water. Klein's idea of swallows employing reeds and straws as means of submersion is rather ludicrous; for these light substances, instead of being proper instruments to assist them to reach the bottom, would infallibly contribute to support them on the surface, and prevent the very object of their intention. Besides, admitting the possibility of their reaching the bottom of lakes and seas, and supposing that they could exist for several months without respiration, What would be the consequence? The whole would soon be devoured by otters, seals, and fishes of various kinds. Nature is always anxious for the preservation of species. But, if the swallow tribes were destined to remain torpid, during the winter months, at the bottom of lakes and seas, she would act in opposition to her own intentions; for, in a season

season or two, the whole genus would be annihilated.

Mr. White of Selborne has favoured us with the following information concerning the migration of swallows : ‘ If ever I saw,’ says he, ‘ any thing like actual migration, it was last Michaelmas-day, 1768. I was travelling, and out early in the morning : At first there was a vast fog ; but, by the time that I was got seven or eight miles from home towards the coast, the sun broke out into a delicate warm day. We were then on a large heath or common, and I could discern, as the mist began to break away, great numbers of swallows clustering on the stunted shrubs and bushes, as if they had roosted there all night. As soon as the air became clear and pleasant, they were all on the wing at once, and, by a placid and easy flight, proceeded on southward towards the sea : After this I did not see any more flocks, only now and then a straggler. When I used to rise in a morning last autumn, and see the swallows and martins clustering on the chimneys and thatch of the neighbouring cottages, I could not help being touched with secret delight, mixed with some degree of mortification : With
‘ delight,

‘ delight, to observe with how much ardour
 ‘ and punctuality those poor little birds obey-
 ‘ ed the strong impulse towards migration, or
 ‘ hiding, imprinted on their minds by their
 ‘ great Creator; and with some degree of mor-
 ‘ tification, when I reflected, that, after all
 ‘ our pains and inquiries, we are yet not quite
 ‘ certain to what regions they do migrate; and
 ‘ are still farther embarrassed to find, that
 ‘ some do not actually migrate at all*.’

In another part of his work, Mr. White
 says: ‘ But we must not deny migration in
 ‘ general; because migration certainly does
 ‘ subsist in some places, as my brother in
 ‘ *Andalusia* has fully informed me. Of the
 ‘ motions of these birds he has ocular demon-
 ‘ stration, for many weeks together, both
 ‘ spring and fall: During which periods, my-
 ‘ riads of the swallow kind traverse the Straits
 ‘ from north to south, and from south to
 ‘ north, according to the season. And these
 ‘ vast migrations consist not only of *hirudines*
 ‘ (swallows), but of *bee-birds*, *hoopoes*, *oropen-*
 ‘ *dulos*, or *golden thrushes*, &c. &c. and also
 ‘ many of our *soft billed summer birds of passage*;
 ‘ and,

* White's Natural History of Selborne, page 64.—65.

‘ and, moreover, of birds which never leave
 ‘ us, such as all the various sorts of hawks
 ‘ and kites. Old Belon, two hundred years
 ‘ ago, gives a curious account of the incredi-
 ‘ ble armies of hawks and kites, which he saw
 ‘ in the spring time traversing the Thracian
 ‘ Bosphorus from Asia to Europe. Besides the
 ‘ above mentioned, he remarks, that the pro-
 ‘ cession is swelled by whole troops of eagles
 ‘ and vultures*.’

Mr. White likewise, with much propriety, remarks, that our inquiries concerning the migration of birds have been too much confined to the swallow tribes; while little attention has been paid to the short-winged birds of passage, such as quails, red-starts, nightingales, white-throats, black-caps, &c. All these, though seemingly ill qualified for long flights, disappear in the winter, and not one of them, notwithstanding their immense numbers, has ever been found in a torpid state.

To mark the times of the arrival and departure of birds of passage in different countries, and in different districts of the same countries, and the probable motives arising from

* White's Natural History of Selborne, page 139.

from the state of the country with regard to heat and cold, and to that of the food peculiar to each kind, would throw much light upon the history of migration. To Mr. White of Selborne we are obliged for the following lists of birds of passage which he has observed in his neighbourhood. These lists are arranged nearly in the order of time.

List of Summer Birds of Passage.

<i>Names.</i>	<i>Usually appear about</i>
1. Wryneck,	Middle of March.
2. Smallest willow-wren,	March 23.
3. House-swallow,	April 13.
4. Martin,	Ibid.
5. Sand-martin,	Ibid.
6. Black-cap,	Ibid.
7. Nightingale,	Beginning of April.
8. Cuckoo,	Middle of April.
9. Middle willow-wren,	Ibid.
10. White-throat,	Ibid.
11. Red-start,	Ibid.
12. Stone-curlew,	End of March.
13. Turtle-dove,	_____
14. Grasshopper lark,	Middle of April.
15. Swift,	April 27.
16. Less reed-sparrow,	_____
17. Land-rail,	_____
18. Largest willow-wren,	End of April.
19. Goat-sucker, or fern-owl,	Beginning of May.
20. Fly-catcher,	{ May 12. This is the latest summer bird of passage.

Most

Most soft-billed birds feed upon insects, and not on grain or seeds; and, therefore, they retire before winter. But the following soft-billed birds, though they eat insects, remain with us during the whole year; such as the red-breast and wren, who frequent out-houses and gardens during the winter, and eat spiders, &c.; the hedge-sparrow, who frequents sinks for crumbs and other sweepings; the white wagtail, the yellow wagtail, and the gray wagtail, who frequent shallow rivulets near the spring heads, where the water seldom freezes, and feed upon the aureliae of insects; the wheat-ear, some of which are to be seen during the winter, &c.

List of Winter Birds of Passage in the neighbourhood of Selborne.

1. The ring-ousel. This bird appears about Michaelmas week, and is a new migration lately discovered by Mr. White.

2. The red-wing, or wind-thrush, appears in Britain about old Michaelmas. They come in great flocks from the frozen regions of the north.

3. Field-fare. These birds visit Britain in immense numbers about Michaelmas, and de-

part about the end of February, or the beginning of March. They pass the summer in the northern parts of Europe, and likewise in Lower Austria*. They breed in the largest trees, feed on berries of all kinds†, but prefer those of the juniper. It is probable that the field-fares which migrate into Britain come from Norway and the northern regions of Europe, because we find that they both breed and winter in Prussia, Austria‡, and the more temperate climates.

4. The Royston crow, or hooded crow of our countryman Sir Robert Sibbald, is likewise a bird of passage. It visits us in the beginning of winter, and departs with the wood-cocks. They frequent the inland as well as the maritime parts of Britain. When near the coasts, they feed upon crabs, muscles, and other shell fishes. They breed in Sweden, build their nests in trees, and lay four eggs§. They likewise breed in the Southern parts of Germany, and particularly on the banks of the Danube||.

5. The

* Kramer Elench. pag. 361.

† Linn. Faun. Suec. sp. 78.

‡ Klein Hist. Avium. pag. 173.

§ Linn. Faun. Suec. sp. 88.

|| Kramer, pag. 333.

5. The wood-cock appears in this country about old Michaelmas. During the summer, wood-cocks inhabit the Alps*, Norway, Sweden†, and the northern parts of Europe. From these countries they retire as soon as the frost commences, which obliges them to migrate into milder climates, where the soil is open, and more adapted to their mode of feeding; for they live on worms, which they search for with their long bills in soft and moist grounds in the midst of woods. Wood-cocks, taking the advantage of the night, or of foggy weather, arrive here in flocks: But they soon separate; and, before returning to their summer quarters, they pair. They fly and feed during the night. They begin their flight in the evening, and return to their retreats in the glades when day commences. They depart from Britain about the end of February or the beginning of March. Some of them, however, like the straggling swallows, have been known to breed, and to remain here during the whole year‡. It is likewise known that wood-cocks

B b 2

migrate

* Willoughby's Ornithology, pag. 290.

† M. de Geer's and Dr. Wallerius's letters to Mr. Pennant.

‡ Pennant's British Zoology, vol. 2. pag. 349. 8vo.

migrate from France, Germany, and Italy, and that they make choice of cold northern climates for their summer residence. About the end of October they visit Burgundy, but remain there four or five weeks only; because it is a dry country, and, on the first frosts, they are obliged to retire for want of sustenance. In the winter, they are found as far south as Smyrna, Aleppo*, and Barbary†. They are even very common in Japan‡.

6. The snipe. Snipes are enrolled as birds of passage by Mr. White, though he acknowledges that some of them constantly breed in England. ‘In winter,’ Mr. Pennant remarks, ‘snipes are very frequent in all our marshy and wet grounds, where they lie concealed in the rushes, &c. In the summer they disperse to different parts, and are found in the midst of our highest mountains, as well as our low moors. Their nest is made of dried grass. They lay four eggs of a dirty olive colour, marked with dusky spots. Their young are so often found in England, that

* Ruffel's History of Aleppo, pag. 64.

† Shaw's Travels, pag. 253.

‡ Kaempfer's Hist. Japan. vol 1. pag. 129.

‘ that we doubt whether they ever entirely leave this island*.’

7. The jack-snipe. This bird, which is very common in Scotland, and frequents the banks of rivers and lakes, is ranked by Mr. White as a winter bird of passage, without mentioning either the time of its arrival or departure; and Mr. Pennant is entirely silent on the subject†.

8. The wood-pigeon. Mr. White, without mentioning either the time of their appearing or disappearing, tells us, that ‘ they seldom appear till late; nor in such plenty as formerly‡.’

9. The wild-swan. During hard winters, this bird frequents the coast of Britain in large flocks; but, from any information we have been able to obtain, it does not breed in our island. Martin, in his History of the Hebrides, or Western Isles§, informs us, that wild swans arrive in great numbers in Lingey, one of the Hebrides, in the month of October, and

* Pennant's British Zoology, vol. 2. pag. 358. 8vo.

† White's Natural History of Selborne, pag. 117.; and Pennant's British Zoology, vol. 2. pag. 359. 8vo.

‡ White's Natural History of Selborne, pag. 117.

§ Description of the Western Isles, pag. 71.

and remain there till March, when they retire more northward to breed. For this purpose, the swans, like most other water fowls, prefer such places as are least frequented by mankind. During summer, the lakes, marshes, and forests of Lapland are filled with myriads of water-fowls. In that northern region, swans, geese, the duck tribe, goosanders, divers, &c. pass the summer; but in autumn they return to us, and other more hospitable shores*.

10. The wild-goose. The wild-geese, it is probable, breed in the retired regions of the north. They arrive here in the beginning of winter, and frequently feed on our corn grounds. They fly at a great height, and observe regularity in their movements. They sometimes form a straight line; and, at others, they assume the shape of a wedge, which facilitates their progress through the resisting air.

With regard to the wild-duck, pochard, wigeon, and teal, though Mr. White places them in the list of birds of passage, he does not mention either the times of their arrival or departure.

* Linn. Flora Lapponica, pag. 273. Oeuvres de Maupertuis, tom. 3. pag. 141.

departure. Though it be probable that most of the duck-kind migrate, yet it is certain, that some individuals of different species of them breed in this country, and continue in it during the whole year. As to the duck-kind, in general, Mr. Pennant remarks: ‘Of the
 ‘ numerous species that form this genus, we
 ‘ know of no more than five that breed here.
 ‘ The *tame swan* and *tame goose*, the *Shield*
 ‘ *duck*, the *eider duck*, and a very small portion of the *wild ducks*. The rest contribute to
 ‘ form that amazing multitude of water fowl
 ‘ that annually repair from most parts of Europe to the woods and lakes of Lapland, and
 ‘ other Arctic regions*, there to perform the
 ‘ functions of incubation and nutrition in full
 ‘ security. They and their young quit their
 ‘ retreat in September, and disperse themselves
 ‘ over Europe. With us they make their appearance the beginning of October, circulate
 ‘ first round our shores, and, when compelled
 ‘ by severe frost, betake themselves to our
 ‘ lakes and rivers†.’

In

* Collect. Voyag. Dutch East India Company, 8vo. 1703. pag. 19. Clusii Exot. pag. 368.

† Pennant's British Zoology, vol. 2. pag. 519.—520.

In winter, the bernacles, or brent-ducks, appear in vast flocks on the north-west coasts of Britain. They are very shy and wild; but, when taken, they soon grow as familiar as our domestic ducks. They leave the British shores in February, and migrate as far as Lapland, Greenland, and even Spitzbergen*.

The solan-geese, or gannets, are likewise birds of passage. They frequent the isle of Ailsay, near the Frith of Clyde; the rocks adjacent to St. Kilda, the most remote of the Hebrides; the Skelig isles, off the coast of Kerry; and the Bass isle in the Frith of Forth. The multitudes which frequent these places are prodigious. To give an idea of their numbers, the reader will not be displeased to see Dr. Harvey's short account of the Bass.

‘ There is a small island in the Frith of Forth,
 ‘ called the *Bass Island*, which does not exceed
 ‘ a mile in circumference. The surface of this
 ‘ island, during the months of May and June,
 ‘ is so entirely covered with nests, eggs, and
 ‘ young birds, that it is scarcely possible to
 ‘ walk without treading on them. The flocks
 ‘ of birds on the wing are so prodigious, that
 ‘ they

* Linn. Amoen. Acad. tom. 4. pag. 585. Barent's Voyage, pag. 19.

‘ they darken the air like clouds, and their
‘ noise is so great, that a man cannot without
‘ difficulty hear his neighbour’s voice. If
‘ from the top of the precipice you look down
‘ upon the sea, you will see it on every side
‘ covered with infinite numbers of birds of
‘ different kinds, swimming about and hunt-
‘ ing for their prey. When sailing round the
‘ island, if you survey the hanging cliffs, you
‘ will perceive, in every cragg, or fissure of the
‘ rocks, innumerable birds of various kinds,
‘ more than the stars of heaven in a serene
‘ night. If you view the distant flocks, either
‘ flying to or from the island, you will ima-
‘ gine them to be a vast swarm of bees*.’ The
rocks of St. Kilda seem to be equally frequent-
ed by solan geese; for Martin, in his descrip-
tion of the Hebrides, informs us, that the inha-
bitants of this small island consume annually
no less than 22,600 young birds of this species,
beside an amazing number of their eggs. The
solan geese and their eggs constitute the chief
food of these islanders. They preserve both
the fowls and the eggs in small pyramidal stone
buildings, which, to protect the food from
moisture,

* Harvey de Generat. Animal. Exercit. 11.

moisture, they cover with the ashes of turf. The solan geese are birds of passage. Their first appearance is in March, and they continue till August or September. But, in general, the times of their breeding and departure seem to coincide with the arrival of the herring, and the migration of that fish from our coasts. It is more than probable that these birds attend the herrings and pilchards during their whole circuit round the British islands; for the appearance of the solan geese is always esteemed by the fishermen as a certain presage of the approach of the herrings or pilchards. In quest of food, these birds migrate as far south as the mouth of the Tagus; for they are frequently seen off Lisbon during the month of December.

The cross-beak, the cross-bill, and the silk-tail, are likewise enumerated by Mr. White as birds of passage. ‘But these,’ says he, ‘are only wanderers that appear occasionally, and are not observant of any regular migration*.’

The long-legged plover, and fanderling, visit us in winter only; and it is worthy of
remark,

* White's Natural History of Selborne, page 118.

remark, that every species of the curlews, wood-cocks, sand-pipers, and plovers*, which forsake us in the spring, retire to Sweden, Poland, Prussia, Norway, and Lapland, both to feed and to breed. They return to us as soon as the young are able to fly; because the frosts, which set in early in these countries, totally deprive them of the means of subsistence. For the same reason they leave us in summer, as the dryness and hardness of the ground prevent them from penetrating the earth with their bills in quest of worms, which constitute the natural food of these birds.

From the facts which have been enumerated, and from others of a similar nature, it is evident, that many birds, both of the land and water kinds, migrate from one climate to another. But, even in the same climate and country, birds occasionally perform partial migrations. During hard winters, when the surface of the earth is covered with snow, many birds, as larks, snipes, &c. retire from the inland parts of the country to the sea-shores, where they pick up a scanty subsistence.

* Linn. Amoen. Acad. tom. 4. pag. 588. Klein de Avium Migrat. pag. 187.

sistance. Others, as the wren, the red-breast, and many of the small birds, or sparrow-kind, resort to gardens, and the habitations of men. Their intention, it is obvious, is to procure food and shelter.

There are three principal objects of migration: Food, temperature of air, and convenient situations for breeding. Such birds as migrate to great distances are alone denominated *birds of passage*. But all birds are, in some measure, birds of passage, though they do not migrate to places so remote from their former abodes. At particular times of the year, most birds migrate from one county to another, or from the more inland districts toward the shores. These partial migrations of small birds are well known to bird-catchers, who make a livelihood by ensnaring them into their nets, and felling them. The birds *fly*, as the bird-catchers term it, about the end of September, and during the months of October and November. There is another, but less considerable, flight in March. Some begin their flight annually about Michaelmas; others, as the wood-lark, succeed, and continue their flight till the middle of October; but the green-finch does not migrate till the frost obliges

obliges it to remove in quest of food and shelter. These partial migrations, or flittings, are performed from day-break till noon. Another, but smaller, flight commences at two o'clock, and continues till night approaches. The times when particular birds migrate from one situation to another are well known to the bird-catchers, who, by means of call-birds, nets, and other devices, seize great numbers of them, and, after accustoming them for some time to restraint and slavery, sell them, for considerable prices, to curious men and whimsical women. A diligent attention to these partial migrations, and their motives, would soon unfold the causes of those of a more extensive kind.

Migration is generally supposed to be peculiar to the feathered tribes. This is a limited idea, which has originated from inattention to the oeconomy of Nature. Birds migrate with a view to remedy the inconveniencies of their present situation, and to acquire a more commodious station with regard to food, temperature, generation, and shelter. From similar motives, men, sometimes in amazing multitudes, have migrated from north to south, displaced the native inhabitants, and fixed establishments

blishments in more comfortable climates than those which they had relinquished. These, in their turn, have fallen victims to fresh and barbarous emigrants. Among the inhabitants of the more northern nations, as Norway, Sweden, Scotland, &c. notwithstanding a very strong attachment to their native countries, there seems to be a natural or instinctive propensity to migrate. Poverty, the rigour of climate, curiosity, ambition, the false representations of interested individuals, the oppression of feudal barons, and similar circumstances, have of late given rise to great emigrations of the human species. But, it is worthy of remark, that the emigrations from south to north, except from the love of conquest in ambitious nations, are so rare, that the instinct seems hardly to exist in those more fortunate climates. Curiosity is a general instinctive principle, which operates strongly in the youthful periods of life, and stimulates every man to visit places that are distant from his ordinary residence. This innate desire is influenced by the relations of travellers, and by many other incentives of a more interested kind. Without the principle of migration, mankind, it is probable, would never have been so universally

versally diffused over the surface of the earth. It is counterbalanced, however, by attachment to those countries which gave us birth, a principle still more powerful and efficient. Love of our native country is so strong, that, after gratifying the migrating principle, almost every man feels a longing desire to return.

Savages, as long as their store of food remains unexhausted, continue in a listless inactive state. They exhaust many days sitting in perfect indolence, and seem not to be prompted by any motives of curiosity. They have not a conception of a man's walking either for amusement or exercise. But, when their provisions begin to fail, an astonishing reverse takes place. They then rouse as from a profound sleep. In quest of wild beasts, birds, and fishes, they migrate to immense distances, exert the greatest feats of activity, and undergo incredible hardships and fatigue. After acquiring a store of provisions, they return to their wonted haunts, and remain inactive till their food again begins to fail.

Quadrupeds likewise perform partial migrations. At the approach of winter, the stag,
the

the rein-deer, and the roebuck, leave the tops of the lofty mountains, and come down to the plains and copses. Their chief objects, in these flittings, are food and shelter. When summer commences, they are harrassed with different species of winged insects, and, to avoid these enemies, they regain the summits of the mountains, where the cold and the height of the situation protect them from the attacks of the flies. In Norway, and the more northern regions of Europe, the oxen, during the winter, migrate to the shores of the sea, where they feed upon sea-plants and the bones of fishes; and Pontoppidan remarks, that the cattle know by instinct when the tide retires, and leaves these articles of food upon the shore. In Orkney and Shetland, the sheep in winter, for the same purposes, uniformly repair to the shore at the ebbing of the tides. Rats, particularly those of the northern regions of Europe, appear from time to time, in such myriads, that the inhabitants of Norway and Lapland imagine the animals fall from heaven. The celebrated Linnaeus, who paid great attention to the oeconomy of these migrating rats, remarked, that they appeared in Sweden periodically every eighteen or
twenty

twenty years. When about to migrate, they leave their wonted abodes, and assemble together in numbers inconceivable. In the course of their journey, they make tracks in the earth of two inches in depth; and these tracks sometimes occupy a breadth of several fathoms. What is singular, the rats, in their march, uniformly pursue a straight line, unless they are forced to turn aside by some unfurmountable obstacle. If they meet with a rock, they first try to pierce it, and, after discovering the attempt to be impracticable, they go round it, and then resume the straight line. Even a lake does not interrupt their passage; for they either traverse it in a straight line or perish in the attempt; and, if they meet with a bark or other vessel, they do not alter their direction, but climb up the one side of it and descend by the other.

Frogs, immediately after their transformation from the tadpole state, leave the water, and migrate to the meadow or marshy grounds in quest of insects. The numbers of young frogs which suddenly make their appearance in the plains, induced Rondeletius, and many other naturalists, to imagine that they were generated in the clouds and

showered down upon the earth. But if, like the worthy and intelligent Mr. Derham, they had examined the situation of the place with regard to stagnating waters, and attended to the nature and transformation of the animals, they would soon have discovered the real cause of the phenomenon.

Of all migrating animals, particular kinds of fishes make the longest journies, and in the greatest numbers. The multiplication of the species, and the procuring of food, are the principal motives of the migration of fishes. The salmon, a fish which makes regular migrations, frequents the northern regions alone. It is unknown in the Mediterranean sea, and in the rivers which fall into it both from Europe and Africa. It is found in some of the rivers of France, that empty themselves into the ocean*. Salmons are taken in the rivers of Kamtschatka†, and appear as far north as Greenland. Salmons live both in the ocean and in fresh waters. For the purpose of depositing their spawn, they quit the sea in the month of September, and ascend the rivers. So strong is the instinct of migrating,

* Rondelet. de Fluviat. pag. 167.

† Hist. Kamtschatka, pag. 143.

migrating, that they press up the rivers with amazing keenness, and scarcely any obstacle is sufficient to interrupt their progress. They spring, with great agility, over cataracts of several feet in height. In their leaps, they spring straight up with a strong tremulous motion, and do not, as has been vulgarly supposed, put their tails in their mouths. When they find a place which they think proper for depositing their eggs, the male and female unite their labours in forming a convenient receptacle for the spawn in the sand, which is generally about eighteen inches deep. In this hole the female deposits her eggs, and the male his milt, which they are said to cover carefully with their tails; for, after spawning, their tails are deprived of skin. The eggs, when not disturbed by violent floods, lie buried in the sand till the spring, and they are hatched about the end of March. The parents, however, after this important office has been performed, hasten back to the sea, in order to cleanse themselves, and to recover their strength. Toward the end of March, the young fry begin to appear, and they gradually increase in size till they acquire the length of four or five inches, and are

Cc 2

then

then called *smelts*, or *smoults* *. About the beginning of May, all the considerable rivers of Scotland are full of salmon-fry. After this period, they migrate to the sea. About the middle of June, the earliest of the fry begin to appear again in the rivers. At that time they are from twelve to sixteen inches long, and gradually augment both in number and size, till about the end of July or the beginning of August, when they weigh from six to nine pounds. This is a very rapid growth. But a gentleman of credit at Warrington informed Mr. Pennant of a growth still more rapid. A salmon, weighing seven pounds and three quarters, was taken on the 7th day of February. It was marked on the back, fin, and tail, with scissars, and then turned into the river. It was retaken on the 17th day of the following month of March, and then it weighed seventeen pounds and a half. The season for fishing salmon in the Tweed begins on the 30th of November, and ends on old Michaelmas day.

* See an Account of the Salmon Fishery on the River Tweed, communicated to Mr. Pennant by Mr. Potts, Brit. Zool. vol. 3. pag. 241. 8vo. edit.

day. In that single river, it is computed that no less than 208000, at a medium, are annually caught, which, together with the products of many other rivers on both sides of Scotland, not only afford a wholesome and palatable food to the inhabitants, but form no inconsiderable article of commerce.

Herrings are likewise actuated by the migrating principle. These fishes are chiefly confined to the northern and temperate regions of the globe. They frequent the highest latitudes, and are sometimes found on the northern coasts of France. They appear in vast shoals on the coast of America, as far south as Carolina. In Chesapeak Bay there is an annual inundation of herrings; and Mr. Catesby informs us, that they cover the shores in such amazing numbers as to become offensive to the inhabitants. The great winter rendezvous of the herrings is within, or near the Arctic Circle, where they remain several months, and acquire strength after being weakened by the fatigues of spawning, and of a long migration. In these seas, insect food is much more abundant than in warmer latitudes. They begin their migration southward
in

in the spring, and appear off the Shetland islands in the months of April and May. These, however, are only the forerunners of the immense shoal which arrives in June. Their approach is recognised by particular signs, such as the appearance of certain fishes, the vast number of birds, as gannets or solan geese, which follow the shoal to prey upon the herrings. But, when the main body arrives, its breadth and depth are so great as to change the appearance of the ocean itself. The shoal is generally divided into columns of five or six miles in length, and three or four in breadth. Their progressive motion creates a kind of rippling or small undulations in the water. They sometimes sink and disappear for ten or fifteen minutes, and then rise again toward the surface. When the sun shines, a variety of splendid and beautiful colours are reflected from their bodies. In their progress southward, the first interruption they meet with is from the Shetland islands. Here the shoal divides into two branches. One branch skirts the eastern, and the other the western shores of Great Britain, and fill every bay and creek with their numbers. Those which proceed to the west from
Shetland,

Shetland, after visiting the Hebrides, where the great fishery is carried on, move on till they are again interrupted by the north of Ireland, which obliges them to divide a second time. One division takes to the west, where they are scarcely perceived, being soon lost in the immensity of the Atlantic Ocean. The other division goes into the Irish Sea, and affords nourishment to many thousands of the human race. The chief object of herrings migrating southward is to deposit their spawn in warmer and more shallow seas than those of the Frigid Zone. This instinct seems not to be prompted by a scarcity of food; for, when they arrive upon our coasts, they are fat and in fine condition; but, when returning to the ocean, they are weak and emaciated. They continue in perfection from the end of June to the beginning of winter, when they begin to deposit their spawn. The great stations of the herring fisheries are off the Shetland and the western islands, and along the coast of Norfolk.

Beside salmons and herrings, there are many fishes which observe a regular migration, as mackerels, lampreys, pilchards, &c. About the middle of July, the pilchards, which are
a species

a species of herrings, though smaller, appear in vast shoals off the coasts of Cornwall. When winter approaches, like the herrings, they retire to the Arctic seas. Though so nearly allied to the herring, it is not incurious to remark, that the pilchards, in their migration for the purpose of spawning, choose a warmer latitude; for, off the coasts of Britain, the great shoals never appear farther north than the county of Cornwall and the Scilly islands. Dr. Borlase, in his history of Cornwall, gives the following account of the pilchard fishery. ‘ It employs,’ says he, ‘ a great
‘ number of men on the sea, training them
‘ thereby to naval affairs; employs men, women, and children, at land, in salting,
‘ pressing, washing, and cleaning, in making
‘ boats, nets, ropes, casks, and all the trades
‘ depending on their construction and sale.
‘ The poor is fed with the offals of the captures, the land with the refuse of the fish
‘ and salt; the merchant finds the gains of
‘ commission and honest commerce, the fisherman the gains of the fish. Ships are often
‘ freighted hither with salt, and into foreign
‘ countries with the fish, carrying off, at the
‘ same time, part of our tin. The usual produce

' duce of the number of hogfheads exported
 ' each year, for ten years, from 1747 to
 ' 1756 inclusive, from the four ports of Tawy,
 ' Falmouth, Penzance, and St. Ives, it ap-
 ' pears, that Tawy has exported yearly 1732
 ' hogfheads; Falmouth, 14631 hogfheads and
 ' two-thirds; Penzance and Mounts-Bay,
 ' 12149 hogfheads and one-third; St. Ives,
 ' 1282 hogfheads: In all amounting to
 ' 29795 hogfheads. Every hogfhead, for ten
 ' years laft paft, together with the bounty al-
 ' lowed for each hogfhead exported, and the
 ' oil made out of each hogfhead, has amount-
 ' ed, one year with another at an average, to
 ' the price of one pound thirteen fhillings and
 ' three pence; fo that the cafh paid for pil-
 ' chards exported has, at a medium, annually
 ' amounted to the fum of L. 49532: 10: 0.'

Of the land-crab there are feveral spe-
 cies. The migration of what is called the
violet land-crab deferves fome notice. It in-
 habits the warmer regions of Europe:
 But its particular refidence is in the tro-
 pical climates of Africa and America. Land-
 crabs generally frequent the mountainous
 parts of the country, which are, of courfe,
 moft remote from the fea. They inhabit
 the

the hollows of old trees, the clefts of rocks, and holes which they themselves dig in the earth. They are extremely numerous. In the months of April and May, they leave their retreats in the mountains, and march in millions to the sea-shore. At this period the whole ground is covered with them; and a man can hardly put down his foot without treading on them*. The object of their migration is to deposit their spawn on the sea-shore. In their progress towards the sea, like the northern rats, the land-crabs move in a straight line. Even when a house intervenes, instead of deviating to the right or left, they attempt to scale the walls. But, when they meet with a river, they are obliged to wind along the course of the stream. In their migration from the mountains, they observe the greatest regularity, and commonly divide into three battalions or bodies. The first consists of the strongest and boldest males, who, like pioneers, march forward to clear the route, and to face the greatest dangers. The females, who form the main body, descend

* Voyage aux Isles Francoises par Labat, tom. 2. pag. 221.

scend from the mountains in regular columns, which are fifty paces broad, three miles long, and so close that they almost entirely cover the ground. Three or four days afterwards, the rear-guard follows, which consists of a straggling undisciplined troop of males and females. They travel chiefly during the night; but, if it rains by day, (for moisture facilitates their motion), they proceed in their slow uniform manner. When the sun shines, and the surface of the ground is dry, they make an universal halt till the evening, and then resume their march. When alarmed with danger, they run backward in a disorderly manner, and hold up their nippers in a threatening posture. They even seem to intimidate their enemies; for, when disturbed, they make a clattering noise with their nippers. But, though they endeavour to render themselves formidable to their enemies, they are cruel to each other. When an individual, by any accident, is so maimed that he cannot proceed, his companions immediately devour him, and then pursue their journey. After a fatiguing and tedious march, which
sometimes

sometimes continues three months before they reach the shore, they prepare themselves for depositing their spawn. The eggs still remain in the bodies of the animals, and are not excluded, as usual to this genus, under the tail. To facilitate the maturation and exclusion of the eggs, the land-crabs no sooner arrive on the shore, than they approach to the margin of the sea, and allow the waves to pass several times over their bodies. They immediately retire to the land; the eggs, in the mean time, come nearer to maturity, and the animals once more go to the water, deposit their eggs, and lay the event to Nature. The bunches of spawn are sometimes as large as a hen's egg; and it is not incurious to remark, that, at this very period, numbers of fishes of different kinds are anxiously waiting for this annual supply of food. Whether the painful migration of the land-crabs, or the wonderful instinct of the fishes which await their arrival, in order to devour their spawn, is the most astonishing fact, we shall leave to the consideration of philosophers. The eggs which escape these voracious

cious fishes are hatched under the sand. Soon after, millions of minute crabs are seen leaving the shore, and migrating slowly toward the mountains. Most of the old ones, however, remain in the flat parts of the country till they regain their strength. They dig holes in the earth, the mouths of which they cover with leaves and mud. Here they throw off their old shells, remain quite naked, and almost without motion for six days, when they become so fat that they are esteemed delicious food. When the new shell has hardened, the animals, by an instinctive impulse, march back to those mountains which they had formerly deserted. In Jamaica, where they are numerous, the land-crabs are regarded as great delicacies; and they are so abundant, that the slaves are often fed entirely upon them.

The migrating principle is not confined to men, quadrupeds, birds, and reptiles: It extends to many of the *insect* tribes. Numberless inhabitants of the air pass the first stages of their existence in the waters. There they remain for longer or shorter periods, according to the species. Previous
to

to their transformation into chrysalids, they quit the waters, and come upon dry ground, where they undergo their amazing change. Instead of active water-worms, they dig or find holes in the earth, where they are converted into chrysalids, or seemingly inanimated beings, and, in a short time, mount into the air in the form of winged insects. Similar migrations are to be observed among land-insects. But migration is not confined to water-worms. Many species of caterpillars which feed upon the leaves of trees, shrubs, and other vegetables, when about to undergo their transformation, leave their former abodes, descend from the trees, and conceal themselves in the earth. The hiving of bees, when numerous colonies remove in order to establish new settlements, is another instance of the migration of insects. Indeed, if we except bees, wasps, ants, and a few others, most insects, whether they inhabit the air, the earth, or the waters, are perfect wanderers, having no fixed place of residence. Some of them, as the spider tribes, build temporary apartments; but, when disturbed,

turbed, they migrate to another commodious place, and erect new habitations.

From the facts which have been enumerated, it is apparent, that the principle of migration, or the desire of changing situations, is not confined to particular birds, but extends through almost the whole system of animation. Men, quadrupeds, birds, fishes, reptiles, insects, all afford striking examples of the migrating principle. From the same facts it is equally apparent, that the general motives for migrating are similar in every class of animals. Food, multiplication of species, and a comfortable temperature of air, are evidently the chief causes which induce animals to remove from one place to another, or, what amounts to the same thing, from one climate to another. Partial emigrations, or emigrations to small distances, are prompted by the same instinctive motives which induce animals of a different structure to undertake long and fatiguing excursions. But, previous to actual migration, what are the peculiar feelings of different animals, and what should stimulate them to proceed uniformly in the direction that ultimately leads them to the situations most accommodated to their wants and their constitutions,

constitutions, are mysteries, with regard to which, like every other part of the oeconomy of Nature, it is the duty of philosophers, instead of attempting to push their inquiries beyond the bounds of human ability, to observe a respectable silence.

CHAP.

CHAPTER XXI.

Of the Longevity and Dissolution of Organised Bodies.

IT is a law of Nature, though a melancholy one, that all organised bodies should be dissolved. The periods of dissolution, however, are as various as the species, and the intentions of Nature in producing them.

In the human kind, the brevity of life is regarded as an object of regret. One half of mankind die before they arrive at eight years of age. From that early period to eighty, beside the destruction of war, and other accidents, Nature kills them annually in millions. Some instances may be given of men whose lives were prolonged beyond the usual period of human existence. Such men are not to be envied; nor should they be considered as favourites of Nature. With respect to maturity of judgment, and a knowledge of the world, no man can be said to exist till he passes thirty years of age. Give him thirty

thirty-five more, and, in general, both mind and body are visibly declined. Those people, therefore, who arrive at an extraordinary age may be said to exist, but they do not live. All intellectual enjoyments and exertions, which constitute the chief dignity and happiness of man, are gone. There are exceptions; but these exceptions are confirmations of what we have advanced. Mankind, in the early ages of the world, have been said to live for several centuries. We mean not to contradict the assertion. But we must remark, that if ever men lived so long, they must have been very different, both in the structure of their bodies and in their manners, from those who now exist. From infancy to manhood, there is a gradual growth or extension of our organs. After this period, and when we advance in years, the bones harden, the muscles turn stiff, the cartilages are converted into bones, the membranes into cartilages, the stomach and bowels lose their tone, and the whole fabric, instead of being soft, flexible, and obedient to the inclinations, or even the commands of the mind, becomes rigid, inactive, and feeble. These are the general and progressive causes of death, and they

they are common to all animals. There are modes of living more favourable to health than others. But examples are not wanting of men who have arrived at extreme old age, without observing either temperance, or any of the other modes of living which are generally supposed to be favourable to longevity. Some men, who lived temperately, and even abstemiously, have reached to great ages: Others, who observed the very opposite conduct, who lived freely, and often intemperately, have had their existence equally prolonged. But, in general, notwithstanding a few exceptions, temperance, a placid and chearful disposition, moderate exercise, and proper exertions of mind, contribute, in no uncommon degree, to the prolongation of life.

A few examples of longevity in the human species, though no general conclusions can be drawn from them, may not be incurious to the reader. We shall not go back to a remote and obscure antiquity, but confine ourselves to more modern times, when the modes of living were nearly the same as they are at present.

On this subject, the celebrated Lord Verulam, in his *Sylva Sylvarum**, gives the following passage, chiefly translated from the seventh book of Pliny's *Natural History*: 'The year of our Lord seventy-six, falling into the time of Vespasian, is memorable; in which we shall find, as it were, a kalender of long-lived men: For that year there was a taxing, (now a taxing is the most authentical and truest informer touching the ages of men), and in that part of Italy which lieth between the Appennine mountains and the river Po, there were found 124 persons that either equalled or exceeded an hundred years of age, namely,

' Fifty-four	-	of 100 years each.
' Fifty-seven	-	110
' Two	-	125
' Four	-	130
' Four	-	135 or 137
' Three	-	140

' Beside these, Parma, in particular, afforded five, whereof,

' Three were	-	120 years each.
' Two	-	130
		' One

* Page 293.

- ‘ One in Bruxelles - 125 years each,
- ‘ One in Placentia - 131
- ‘ One in Faventia - 132
- ‘ A certain town, then called Velleiatium, si-
- ‘ tuate in the hills about Placentia, afforded
- ‘ ten, whereof
 - ‘ Six were - - 110 years each.
 - ‘ Four - - 120
 - ‘ One in Rimino, whose
 - ‘ name was Marcus
 - ‘ Aponius - - 150.’

The most extraordinary instance of longevity in Great Britain was exhibited in the person of Henry Jenkins. He was a native of Yorkshire, lived to the amazing age of 169 years, and died on the 8th day of December 1670.

Next to Jenkins, we have the famous Thomas Parre, who was a native of Shropshire, and died on the 16th day of November 1635, at the age of 152.

Francis Confist, a native of Yorkshire, aged 150, died in January 1768.

Margaret

Margaret Forster, aged 136, and her daughter, aged 104, were natives of Cumberland, and both alive in the year 1771.

William Evans, aged 145, lived in Carnarvon, and still existed in the year 1782.

Dumiter Radaloy, aged 140, lived in Harmentstead, and died on the 16th day of January 1782.

James Bowels, aged 152, lived in Killingworth, and died on the 15th day of August 1656.

The Countess of Desmond, in Ireland, saw her 140th year.

Mr. Eccleston, a native of Ireland, lived to the age of 143, and died in the year 1691.

John Mount, a native of Scotland, saw his 136th year, and died on the 27th day of February 1776.

William Ellis of Liverpool, died on the 16th day of August 1780, at the age of 130.

Colonel Thomas Winsloe, a native of Ireland, aged 146, died on the 22d day of August 1766.

John Taylor was born in Carrygill, in the county of Cumberland. He was bred a miner.

His

His father died when John was only four years of age. Poverty obliged him to be set early to work. During two years he dressed lead ore for 2d. a-day. The next three or four years he assisted the miners in removing the ore and rubbish to the bank, for which he received 4d. a-day. At this period there happened a great solar eclipse, which was distinguished in Scotland by the appellation of *Mirk Monday**. This event, which he always repeated with the same circumstances, is the chief æra from which John's age has been computed. After labouring many years both in this and the neighbouring kingdom, he died, near Leadhills in Scotland, in the month of May 1770, at the great age of 133.

Though the above modern examples of extraordinary longevity rest chiefly on the authority of periodical publications, yet there is not a doubt, that, in all countries, and at all times, some persons of both sexes have arrived at ages far beyond the common periods of human life. If the reader is desirous of seeing many instances of longevity, he may consult

Bacon's

* *Mirk*, in the Scottish dialect, signifies *dark*; and the eclipse happened in the year 1652.

Bacon's *History of Life and Death**, Whitehurst's *Inquiry into the Original State and Formation of the Earth*†, and Dr. Fothergill's *Observations on Longevity*‡.

The general causes of death have already been mentioned. But, in women, the operation of these causes is frequently retarded. In the female sex, the bones, the cartilages, the muscles, as well as every other part of the body, are softer and less solid than those of men: Neither are they generally so much subjected to bodily exertions. Their constituent parts, accordingly, require more time in hardening to that degree which occasions death. Women, of course, ought to live longer than men. This reasoning is confirmed by the bills of mortality; for, upon consulting them, it appears, that, after women have passed a certain time, they live much longer than men who have reached the same period. The duration of the lives of animals may, in some measure, be estimated by the time occupied in their growth. An animal, or even a plant, as we learn

* Sylva Sylvarum, pag. 273. &c.

† 2d Edit. pag. 165.

‡ Annual Register, Natural History division, pag. 61.

learn from experience, which acquires maturity in a short time, perishes much sooner than those which are longer in arriving at that period. In the human species, when individuals grow with uncommon rapidity, they generally die young. This circumstance seems to have given rise to the common proverbial expression, *Soon ripe soon rotten*. Man grows in stature till he be sixteen or eighteen years of age; but the thickness of his body is not completely unfolded before that of thirty. Dogs acquire their full length in one year; but their growth in thickness is not finished till the end of the second. A man, who continues to grow for thirty years, may live ninety or a hundred: But a dog, whose growth terminates in two or three years, lives only ten or twelve. The same observation is applicable to most animals. Fishes continue to grow for a great number of years. Some of them, accordingly, live during several centuries; because their bones and cartilages seldom acquire the density of those of other animals. It may, therefore, be considered as a general fact, that large animals live longer than small ones, because the former require more time to complete their growth. Thus
the

the causes of our dissolution are inevitable ; and it is equally impossible to retard that fatal period, as to change the established laws of Nature. When the constitution is sound, life may, perhaps, by moderating the passions, and by temperance, be prolonged for a few years. But the varieties of climate, and of the modes of living, make no material differences with regard to the period of our existence, which is nearly the same in the European, the Negro, the Asiatic, the American, the civilized man and the savage, the rich and the poor, the citizen and the peasant. Neither does the difference of food, or of accommodation, make any change on the duration of life. Men, who are fed on raw flesh or dried fish, on sago or rice, on cassada or roots, live as long as those who use bread and prepared victuals. If luxury and intemperance be excepted, nothing can alter those laws of mechanism which invariably determine the number of our years. Any little differences which may be remarked in the term of human life, seem to be chiefly owing to the quality of the air. In general, there are more old men in high than in low countries. The mountains of Scotland, of Wales, and of Switzerland, have furnished

furnished more examples of longevity than the plains of Holland, Flanders, Germany, or Poland. But, if we take a survey of mankind, whatever be the climate they inhabit, or their mode of living, there is scarcely any difference in the duration of life. When men are not cut off by accidental diseases, individuals may every where be found who live ninety or a hundred years. Our ancestors, with few exceptions, never exceeded this period; and, since the days of David, King of the Jews, it has undergone no variation. Beside accidental diseases, which are more frequent, as well as more dangerous, in the latter periods of life, old men are subjected to natural infirmities that originate solely from a decay of the different parts of the body. The muscles lose their tone, the head shakes, the hands tremble, the limbs totter, the sensibility of the nerves is blunted, the cavities of the vessels contract, the secretory organs are obstructed, the blood, the lymph, and the other fluids, extravasate, and produce all those symptoms and diseases which are commonly ascribed to a vitiation of the humours. The natural decay of the solids, however, appears to be the original cause of all these maladies.

dies. It is true, that a bad state of the fluids proceeds from a depravity in the organization of the solids. But the effects resulting from a noxious change in the fluids produce the most alarming symptoms. When the fluids stagnate, or if, by a relaxation of the vessels, an extravasation takes place, they soon corrupt, and corrode the weaker parts of the solids. Hence the causes of dissolution gradually, but perpetually, multiply, our internal enemies grow more and more powerful, and at last put a period to our existence.

With regard to *Quadrupeds*, the causes of their dissolution are precisely the same with those which destroy the human species. The times of their growth bear, likewise, some proportion to the duration of their lives. But, as we have already given a Table of the ages at which different quadrupeds are capable of multiplying their species, and of the general duration of their lives, to avoid unnecessary repetitions, we must refer the reader to page 32, of this volume.

Some *Birds* afford instances of great longevity. In this class of animals, the duration of life is by no means proportioned to the times of their growth. Most of them acquire
their

their full dimensions in a few months, and are capable of multiplying the species the first spring or summer after they are hatched. In proportion to the size of their bodies, birds are much more vivacious, and live longer than either men or quadrupeds. Swans have been said to live three hundred years; but, though mentioned by respectable writers, the assertion is not supported by any authentic evidence. Mr. Willoughby, in his Ornithology*, remarks, ‘ We have been assured by a friend of ours, a person of very good credit, that his father kept a goose known to be four-score years of age, and as yet sound and lusty, and like enough to have lived many years longer, had he not been forced to kill her for her mischievousness, worrying and destroying the young geese and goslings.’ In another part of his valuable work, Mr. Willoughby tells us, ‘ that he has been assured by credible persons, that a goose will live a hundred years or more†.’ In man and quadrupeds, the duration of life bears some proportion to the times of their growth. But, in birds,

* Page 14.

† Ornithology, page 256.

birds, their growth, and their powers of reproduction, are more rapid, though they live proportionally longer. Some species of birds, as all the gallinaceous tribes, can make use of their limbs the moment they issue from the shell; and, in a month or five weeks after, they can likewise employ their wings. A dunghill cock has the capacity of engendering at the age of four months, but does not acquire his full growth in less than a year. The smaller birds are perfect in four or five months. They grow more rapidly, and produce much sooner than quadrupeds, and yet they live proportionally much longer. In man and quadrupeds, the duration of life is about six or seven times more than that of their growth. According to this rule, a cock or a parrot, who arrive at their full growth and powers in one year, should not live above six or seven. But Nature knows none of our rules. She accommodates her conduct, not to our shallow, and often presumptuous conclusions, but to the preservation of species, and to the support and general balance of the great system of animated beings. Ravens, though capable of providing for themselves in less than a year, sometimes have their lives protracted

protracted more than a century. The Count de Buffon informs us, that, in several places of France, ravens have been known to arrive at this extraordinary age, and that, at all times, and in all countries, they have been esteemed birds of great longevity*.

‘Eagles,’ says Mr. Pennant, ‘are remarkable for their longevity, and for their power of sustaining a long abstinence from food. A golden eagle, which has now been nine years in the possession of Owen Holland, Esq. of Conway, lived thirty-two years with the gentleman who made him a present of it; but what its age was when the latter received it from Ireland is unknown. The same bird also furnishes a proof of the truth of the other remark, having once, through the neglect of servants, endured hunger for twenty-one days, without any sustenance whatsoever†.’ The pelican that was kept at Mechlin in Brabant during the reign of the Emperor Maximilian, was believed to be eighty years of age. ‘What is reported of the age of eagles and ravens,’ says Mr. Willoughby,

* Hist. Nat. des Oiseaux, tom. 3. pag. 32.

† British Zoology, vol. 1. 8vo edit. page 123.

loughby, ' although it exceeds all belief, yet
 ' doth it evince that those birds are very long-
 ' lived*.' Pigeons have been known to live
 from twenty to twenty-two years. Even
 the smaller birds live very long in proportion
 to the time of their growth and the size of their
 bodies. Linnets, gold-finches, &c. often live
 in cages fifteen, twenty, and even twenty-
 three years.

Fishes, whose bones are more cartilaginous
 than those of men and quadrupeds, are long of
 acquiring their utmost growth, and many of
 them live to great ages. Gefner gives an in-
 stance of a carp in Germany which he knew to
 be one hundred years old*. Buffon in-
 forms us, that, in the Count Maurepa's ponds,
 he had seen carps of one hundred and fifty
 years of age, and that the fact was attested in
 the most satisfactory manner. He even men-
 tions one which he supposed to be two hun-
 dred years old†. Two methods have been de-
 vised for ascertaining the age of fishes, namely,
 by the circles of the scales, and by a transverse
 section of the back-bone. When a scale of a
 fish

* Ornithology, page 147.

† Gefner de Pisc. pag. 312.

‡ Epoque de la Nature, pag. 181.

fish is examined by the microscope, it is found to consist of a number of circles within one another, resembling, in some measure, those rings that appear on the transverse sections of trees, by which their ages are computed. In the same manner the ages of fishes may be ascertained by the number of circles on their scales, reckoning for each ring one year of the animal's existence. The ages of Buffon's carps were chiefly determined by the circles on their scales. The age of fishes that want scales, as the skate and ray-kind, may be pretty exactly known by separating the joints of the backbone, and observing minutely the number of rings which the surface exhibits. Both of these methods may be liable to deception; but they are the only natural ones which have hitherto been discovered. The longevity of fishes has been ascribed to several causes. The element in which they live is more uniform, and less subject to accidental changes than the air of our atmosphere. Their bones, which are more of a cartilaginous nature than those of land animals, admit of indefinite extension; of course, their bodies, instead of suffering the rigidity of age at an early period, which

is the natural cause of death, continue to grow much longer than those of most land-animals.

As to the age of *Reptiles*, probably from the uninteresting nature of the animals, we have very little information. But two letters of J. Arscott, Esq. of Tehott in Devonshire, concerning the longevity of a *toad*, deserve some notice. These letters were addressed to Dr. Milles, Dean of Exeter, and by him communicated to Mr. Pennant in the year 1768: ‘It
‘ would give me the greatest pleasure,’ says Mr. Arscott, ‘ to be able to inform you of any
‘ particulars worthy Mr. Pennant’s notice,
‘ concerning the toad who lived so many years
‘ with us, and was so great a favourite.—It
‘ had frequented some steps before the hall-
‘ door some years before my acquaintance commenced with it, and had been admired by
‘ my father for its size, (which was of the largest I ever met with), who constantly paid it
‘ a visit every evening. I knew it myself
‘ above *thirty* years, and, by constantly feeding it, brought it to be so tame, that it
‘ always came to the candle, and looked up,
‘ as if expecting to be taken up and brought
‘ upon

‘ upon the table, where I always fed it with
 ‘ insects of all sorts.—You may imagine that
 ‘ a toad, generally detested, (although one of
 ‘ the most inoffensive of all animals), so much
 ‘ taken notice of and befriended, excited the
 ‘ curiosity of all comers to the house, who all
 ‘ desired to see it fed; so that even ladies so
 ‘ far conquered the horrors instilled into them
 ‘ by nurses, as to desire to see it*.’ In the
 second letter Mr. Arscott remarks, ‘ I cannot
 ‘ say how long my father had been acquainted
 ‘ with the toad before I knew it; but, when
 ‘ I was first acquainted with it, he used to
 ‘ mention it as the old toad I have known so
 ‘ many years; I can answer for *thirty-six*
 ‘ years†.’—‘ In respect to its end, had it not
 ‘ been for a tame raven, I make no doubt but
 ‘ it would have been now living, who one day,
 ‘ seeing it at the mouth of its hole, pulled it
 ‘ out, and, though I rescued it, pulled out
 ‘ one eye, and hurt it so, that, notwith-
 ‘ standing its living a twelvemonth, it never
 ‘ enjoyed itself, and had a difficulty in taking
 ‘ its food, missing the mark for want of its eye.

E c 2

‘ Before

* Pennant's British Zoology, vol. 3. pag. 323.

† Ibid. pag. 326.

‘ Before that accident it had all the appearance
‘ of perfect health*.’

Most *Insects*, especially after their last transformation, are short-lived. But the species are continually supported by their wonderful fecundity. Those animals whose parts require a long time of hardening and expanding are endowed with a proportional degree of longevity. Insects grow, and their bodies harden, more quickly than those of larger animals. Many of them complete their growth in a few weeks, and even in a few days. The duration of their existence is accordingly limited to very short periods. Some species of flies lie in a torpid state during the winter, and revive when the heat of spring or summer returns. The ephemeron flies, of which there are several kinds, seldom live above one day, or one hour, after their transformation. But, to continue the species, Nature has taken care that myriads of males and females should be transformed nearly at the same instant. Were it otherwise, the males and females could have no opportunity of meeting, and the species would soon be extinguished. Other kinds
are

are transformed more irregularly, and live several days. Here the wisdom of Nature is conspicuous: She prolongs the existence of these animals for no other purpose but to allow the individuals of both sexes to meet and multiply the species. Bees, and flies of all kinds, after lying long in water, and having every appearance of death, revive by the application of a gentle heat, or by covering their bodies with ashes, chalk, or sand, which absorb the superfluous moisture from their pores. Reaumur made many experiments upon the reviviscence of drowned bees. He found, that, after being immersed in water for nine hours, some of them returned to life; but he acknowledges that many of them, in the fourth part of this time, were actually dead, and that neither heat, nor the application of absorbent powders, could restore them to life. Analogical reasoning is often deceitful, but it frequently leads to useful truths. As flies of all kinds, after immersion in water, and exhibiting every mark of actual death, can be restored to life by covering their bodies with any absorbent substance, without the assistance of a heat superior to that of the common atmosphere, might not the ordinary methods employed

ployed for the recovery of drowned persons be assisted by the application of warm ashes or chalk? The structure of a fly and that of a man, it is allowed, are very different. But, in desperate cases, when every other method fails, no fact should be overlooked, and no analogy despised.

Plants differ as much in the periods of their existence as animals. Many plants perish yearly; others are biennial, triennial, &c. But the longevity and magnitude of particular trees are prodigious. We are informed by Mr. Evelyn, that, in the bodies of some English oaks, when cut transversely, three, and even four hundred rings of wood have been distinguished. A ring of wood is added annually to the trunks of trees; and, by counting the rings, the age of any tree may be pretty exactly ascertained*. With regard to the magnitude of oaks, some of them are huge masses. Dr. Hunter, in his *Notes upon Evelyn's Sylva*, remarks, 'that none
' of the oaks mentioned by Mr. Evelyn bear
' any proportion to one now growing at Cow-
' thorpe, near Wetherby, upon an estate be-
' longing to the Right Hon. Lady Stourton.
' The

* See Evelyn's *Sylva*, page 505.

‘ The dimensions are almost incredible. With-
 ‘ in three feet of the surface, it measures six-
 ‘ teen yards, and, close by the ground, twen-
 ‘ ty-six yards. Its height, in its present and
 ‘ ruinous state, (1776), is about eighty-five feet,
 ‘ and its principal limb extends sixteen yards
 ‘ from the bole.—When compared to this, all
 ‘ other trees are but *children* of the forest*.’

From the facts which have been enumerated, it appears, that all animals, as well as vegetables, have stated periods of existence, and that their dissolution is uniformly accomplished by a gradual hardening and desiccation of their constituent parts. No art, no medicine, can retard the operations of Nature. It is, therefore, the wisdom and the duty of every human being to sail down the irresistible current of Nature with all possible tranquillity and resignation. Life, whether short or long, whether fortunate or unfortunate, when the fatal period arrives, is of little consequence to the individual. Society, knowledge, virtue, and benevolence, are our only rational enjoyments, and ought to be cultivated with diligence.

With regard to animals in general, the actual duration of their lives is very different. But the

* See Evelyn's *Sylva*, page 500.

the comparative shortness or length of life, in particular animals. probably depends on the quickness or slowness of the ideas which pass in their minds, or of the impressions made upon their senses. A rapid succession of ideas or impressions makes time seem proportionally long. There is likewise a connection between the quickness and slowness of ideas, and the circulation of the blood. A man whose pulse is slow and sluggish, is generally dull and phlegmatic. Raise this same man's pulse with wine, or any other exhilarating stimulus, and you immediately quicken his sensations, as well as the train of his ideas. In all young animals, the circulation of the blood is much more rapid than after they have acquired their full growth. Young animals, accordingly, are frolicsome, vivacious, and happy. But, when their growth is completed, the motion of the blood is slower, and their manners, of course, are more sedate, gloomy, and pensive. Another circumstance merits attention. The circulation of the blood is slower or quicker in proportion to the magnitude of animals. In large animals, such as man and quadrupeds, the blood moves slowly, and the succession of their ideas is proportionally slow. In the more minute kinds, as mice,
small

small birds, squirrels, &c. the circulation is so rapid that the pulses of their arteries cannot be counted. Now, animals of this description astonish us with the quickness of their movements, the vivacity of their manners, and the extreme chearfulness of their dispositions.

Reaumur, Condillac, and many other philosophers, consider duration as a relative idea, depending on a train of conscious perception and sentiment. It is certain that the natural measure of time depends solely on the succession of our ideas. Were it possible for the mind to be totally occupied with a single idea for a day, a week, or a month, these portions of time would appear to be nothing more than so many instants. Hence a philosopher often lives as long in one day, as a clown or a savage does in a week or a month spent in mental inactivity and want of thought.

This subject shall be concluded with a single remark: If it be true, and we are certain that it is so in part, that animals of every species, whatever be the real duration of their lives; from a slow or rapid succession of ideas, and perhaps from the comparative intensity of their enjoyments, live equally long, and enjoy an equal portion of individual happiness, it opens
a wonderful

a wonderful view of the great benevolence of Nature. To store every portion of this globe with animal life, She has amply peopled the earth, the air, and the waters. The multifarious inhabitants of these elements, as to the actual duration of their lives, are extremely diversified. But, by variation of forms, of magnitude, of rapidity of ideas, of intensity of pleasures, and, perhaps, of many other circumstances, She has conferred upon the whole nearly an equal portion of happiness.

CHAP.

CHAPTER XXII.

Of the Progressive Scale or Chain of Beings in the Universe.

TO men of observation and reflection, it is apparent, that all the beings on this earth, whether animals or vegetables, have a mutual connection and a mutual dependence on each other. There is a graduated scale or chain of existence, not a link of which, however seemingly insignificant, could be broken without affecting the whole. Superficial men, or, which is the same thing, men who avoid the trouble of serious thinking, wonder at the design of producing certain insects and reptiles. But they do not consider that the annihilation of any one of these species, though some of them are inconvenient, and even noxious to man, would make a blank in Nature, and prove destructive to other species who feed upon them. These, in their turn, would be the cause of destroying other species, and the system of devastation would gradually

ally proceed, till man himself would be extirpated, and leave this earth destitute of all animation.

In the chain of animals, man is unquestionably the chief or capital link, and from him all the other links descend by almost imperceptible gradations. As a highly rational animal, improved with science and arts, he is, in some measure, related to beings of a superior order, wherever they exist. By contemplating the works of Nature, he even rises to some faint ideas of her great Author. Why, it has been asked, are not men endowed with the capacity and powers of angels? beings of whom we have not even a conception. With the same propriety, it may be asked, Why have not beasts the mental powers of men? Questions of this kind are the results of ignorance, which is always petulant and presumptuous. Every creature is perfect, according to its destination. Raise or depress any order of beings, the whole system, of course, will be deranged, and a new world would be necessary to contain and support them. Particular orders of beings should not be considered separately, but by the rank they hold in the general system. From man to the minutest animalcule

animalcule which can be discovered by the microscope, the chasm seems to be infinite : But that chasm is actually filled up with sentient beings, of which the lines of discrimination are almost imperceptible. All of them possess degrees of perfection or of excellence proportioned to their station in the universe. Even among mankind, which is a particular species, the scale of intellect is very extensive. What a difference between an enlightened philosopher and a brutal Hottentot! Still, however, Nature observes, for the wisest purposes, her uniform plan of graduation. In the human species, the degrees of intelligence are extremely varied. Were all men philosophers, the business of life could not be executed, and neither society, nor even the species, could long exist. Industry, various degrees of knowledge, different dispositions, and different talents, are great bonds of society. The Gentoos, from certain political and religious institutions, have formed their people into different casts or ranks, out of which their posterity can never emerge. To us, such institutions appear to be tyrannical, and restraints on the natural liberty of man. In some respects they are so : But they seem to have been originally results

results of wisdom and observation; for, independently of all political institutions, Nature herself has formed the human species into casts or ranks. To some she gives superior genius and mental abilities; and, even of these, the views, the pursuits, and the tastes, are most wonderfully diversified.

In the talents and qualities of quadrupeds of the same species, there are often remarkable differences. These differences are conspicuous in the various races of horses, dogs, &c. Even among the same races, some are bold, sprightly, and sagacious. Others are comparatively timid, phlegmatic, and dull.

Our knowledge of the chain of intellectual and corporeal beings is very imperfect; but what we do know gives us exalted ideas of that variety and progression which reign in the universe. A thick cloud prevents us from recognising the most beautiful and magnificent parts of this immense chain of being. We shall endeavour, however, to point out a few of the more obvious links of that chain, which falls under our own limited observation.

Man,

Man, even by his external qualities, stands at the head of this world. His relations are more extensive, and his form more advantageous, than those of any other animal. His intellectual powers, when improved by society and science, raise him so high, that, if no degrees of excellence existed among his own species, he would leave a great void in the chain of being. Were we to consider the characters, the manners, and the genius of different nations, of different provinces and towns, and even of the members of the same family, we should imagine that the species of men were as various as the number of individuals. How many gradations may be traced between a stupid Huron, or a Hottentot, and a profound philosopher? Here the distance is immense; but Nature has occupied the whole by almost infinite shades of discrimination.

In descending the scale of animation, the next step, it is humiliating to remark, is very short. Man, in his lowest condition, is evidently linked, both in the form of his body and the capacity of his mind, to the large and small orang-outangs. These again, by another slight gradation, are connected to the apes, who, like the former, have no tails. It is wonderful that

Linnaeus,

Linnaeus, and many other naturalists, should have overlooked this gradation in the scale of animals, and maintained, that the island of Nicobar, and some other parts of the East Indies, were inhabited by tailed men. Before those animals, whose external figure has the greatest resemblance to that of man, are ornamented, or rather deformed, with tails, there are several shades of discrimination. The larger and smaller orang-outangs, which are real brutes, have no tails. Neither are the numerous tribes of apes furnished with this appendage. But the believers in tailed men gravely tell us, that there is nothing surprising in this phenomenon, because a tail is only a prolongation of the *os coccygis*, which is the termination of the back-bone. They consider not, however, that, instead of accounting for the existence of tailed men, they do nothing more than substitute a learned circumlocution for the simple word *tail*. It is here worthy of remark, that a philosopher, who has paid little attention to natural history, is perpetually liable to be deceived; and that a naturalist, I mean a nomenclator, without philosophy, though he may be useful by mechanically marking distinctions, is incapable of enriching our
minds

minds with general ideas. A proper mixture of the two is best calculated to produce a real philosopher. From the orang-outangs and apes to the baboons, the interval is hardly perceptible. The true apes have no tails, and those of the baboons are very short. The monkeys, who form the next link, have long tails, and terminate this partial chain of imitative animals, which have such a detestable resemblance to the human frame and manners.

When examining the characters by which beings are distinguishable from each other, we perceive that some of them are more general and include a greater variety than others. From this circumstance all our distributions into classes, orders, genera, and species, are derived. Between two classes, or two genera, however, Nature always exhibits intermediate productions so closely allied, that it is extremely difficult to ascertain to which of them they belong. The polypus, which multiplies by shoots, or by sections, from its body, connects the animal to the vegetable kingdom. Those worms which lodge in tubes composed of sand, seem to link the insects to the shell and crustaceous animals. Shell-animals and crustaceous

insects make also a near approach to each other. Both of them have their muscles and instruments of motion attached to external instead of internal bones. From reptiles, the degrees of perfection in animal life and powers move forward in a gradual but perceptible manner. The number of their organs of sense, and the general conformation of their bodies, begin to have a greater analogy to the structure of those animals which we are accustomed to consider as belonging to the more perfect kinds. The snake, by its form, its movements, and its mode of living, is evidently connected with the eel and the water-serpent. Like reptiles, most fishes are covered with scales, the colours and variety of which often enable us to distinguish one species from another. The forms of fishes are exceedingly various. Some are long and slender; others are broad and contracted. Some fishes are flat, others cylindrical, triangular, square, circular, &c. The fins of fishes, from the medium in which they live, are analogous to the wings of birds. Like those of reptiles, the heads of fishes are immediately connected to their bodies, without the intervention of necks. The flying fishes, whose fins resemble the wings of
bats,

bats, form one link which unites the fishes to the feathered tribes. Aquatic birds succeed, by a gentle gradation, the flying fishes.

In tracing the gradations from fishes to quadrupeds, the transition is almost imperceptible. The sea-lion, the morse, all the cetaceous tribes, the crocodile, the turtle, the seals, have such a resemblance, both in their external and internal structure, to terrestrial quadrupeds, that some naturalists, in their methodical distributions, have ranked them under the same class of animals. The bats, and the flying squirrels, who traverse the air by means of membranous instead of feathered wings, evidently connect quadrupeds with birds. The ostrich, the cassowary, and the dodo, who rather run than fly, form another link between the quadruped and the bird.

All the substances we recognise on this earth may be divided into organised and animated, organised and inanimated, and unorganised, or brute matter. The whole of these possess degrees of perfection, of excellence, or of relative utility, proportioned to their stations or ranks in the universe. Change these stations or ranks, and another world would be necessary to contain and support them. Beings must

not be contemplated individually, but by their rank, and the relations they have to the constituent parts of the general system of Nature. Certain results of their natures we consider as evils. Destroy these evils, and you annihilate the beings who complain of them. The reciprocal action of the solids and fluids constitutes life, and the continuation of this action is the natural cause of death. Immortality on this earth, therefore, pre-supposes another system; for our planet has no relation to immortal beings. Every animal, and every plant, rises, by gentle gradations, from an embryo, or gelatinous state, to a certain degree of perfection exactly proportioned to their several orders. An assemblage of all the orders of relative perfection constitutes the absolute perfection of the whole. All the planets of this system gravitate toward the sun and toward each other. Our system gravitates toward other systems, and they to ours. Thus the whole universe is linked together by a gradual and almost imperceptible chain of existences both animated and inanimated. Were there no other argument in favour of the UNITY of DEITY, this uniformity of design, this graduated concatenation

catenation of beings, which appears not only from this chapter, but from many other parts of the work, seems to be perfectly irrefragable.

In contemplating Man, as at the head of those animals with which we are acquainted, a thought occurred, that no sentient being, whose mental powers were greatly superior, could possibly live and be happy in this world. If such a being really existed, his misery would be extreme. With senses more delicate and refined; with perceptions more acute and penetrating; with a taste so exquisite that the objects around him could by no means gratify it: obliged to feed upon nourishment too gross for his frame; he must be born only to be miserable, and the continuation of his existence would be utterly impossible. Even in our present condition, the sameness and insipidity of objects and pursuits, the futility of pleasure, and the infinite sources of excruciating pain, are supported with great difficulty by cultivated and refined minds. Increase our sensibilities, continue the same objects and situation, and no man could bear to live.—
Let man, therefore, be contented. His station
in

in the universal scale of Nature is fixed by Wisdom. Let him contemplate and admire the works of his Creator ; let him fill up his rank with dignity, and consider every partial evil as a cause or an effect of general good.— This is the whole duty of man.



INDEX.

I N D E X.

The small Numerals denote the Volume, and the Figures refer to the Page.

A

ACTINIA. See sea-nettle.

Air, necessary to the existence of all animals and vegetables, i. 163.

Air-cells in birds described, 174. Temporary instruments sometimes provided for its admission into animal bodies, 191. Some animals can live long without it, 200, 201. Air is always impregnated with odorous particles, 256. The medium of sounds, 265,

Amphibious animals. See animals. Sketch of their structure and dispositions, i. 102. The foramen ovale of their hearts continue open during life, 104.

Analogy. See animals and plants. Analogy between birds and fishes, i. 186. Sexes of plants founded on false analogies, 389. See sexes.

Animal heat. An attempt to account for it, i. 164.

Animalcules. Those obtained by infusions multiply by continued divisions and subdivisions, i. 48.

Animals. Difficulty of distinguishing them from plants, i. 2. See plants. All of them endowed with sensation, 12. A sketch of their structure and organs, 22. Analogies between animals and plants, originating from their structure and organs, *ibid.*—
from

from their growth and nourishment, 38—46. The food of animals compared with that of plants, 39. Analogies from their dissemination and decay, 46, &c. Some animals neither viviparous nor oviparous, 51; some are both, *ibid.*; and some multiply without impregnation, 53. Analogies between the eggs of animals and the seeds of plants, 55. Most animals have their seasons, 61, *ii.* 28. All animals subject to diseases and death, *i.* 63. Of the organs and general structure of animals, 68. Structure of man, 69. Of the bones, *ibid.* Of the muscular parts, 71. Of the lungs, 73. Of the stomach and instruments of digestion, *ibid.* Of the organs of generation, 75. Of the brain and nerves, 79. Of the structure of quadrupeds, 82. The general structure of quadrupeds has a great resemblance to that of man, 83. Peculiarities in the structure of carnivorous animals, 88; and of the herbivorous tribes, 90. Sketch of the structure and dispositions of amphibious animals, 102. Sketch of the structure of birds, 110. Of the structure of fishes, 121. The comparative strength of animals depends not on structure alone, 160. Of their respiration, 162. Most animals capable of expressing their wants and desires, 170. Of their motions, 208, &c. The notion that animals are machines absurd, 247. Of the infancy of animals, 308. Their general diffusion over the globe owing partly to the diversity of their appetites for food, 347. Of the sexes of animals, 374. Of the puberty of animals, *ii.* 1. All animals undergo changes at the age of puberty, 5. Their attachment to their young, 15. This attachment ceases, in some animals, as soon as the young can provide for themselves, 22. Many of them marry or pair, 23. Advantages derived from the variety of seasons observed by different animals, 28. Table of their relative fecundity, 32. Of their transformations, 36. All animals undergo changes, *ibid.* Crustaceous tribes annually cast their shells, 42. Of the habitations of animals, 75. Operations of animals referred by some authors to mechanical impulses, 117. Of their hostilities, 184. Man the most universal destroyer of animal life, 186.

Some

Some animals devour their own species, 201. Advantages derived from animals preying upon one another, 211. Profusion of animal life seems to be a general intention of Nature, 215. There is a wonderful balance in the system of animal destruction and multiplication, 217. Restraints against noxious inundations of particular species, 218. Animals not destined for individual existence alone, 224. Of the artifices of animals, 226. Of the society of animals, 252. Of gregarious animals who carry on no common operations, 282. Different species associate, 285. Of their docility, 287. Animals of the ox kind dull and phlegmatic, 323. Much influenced by climate and domestication, 328, &c. Of the characters of animals, 335. Of their principle of imitation, 343. Of the migration of animals, 350. Of their longevity, 401, &c. Those which grow quickly soon perish, 408. All animals perfect according to their destination, 428.

Ants. Their structure and manners, i. 149. Wood-ants, their surprising operations and manners. See termites. Their society, ii. 280.

Aphis. See puceron.

Apterous insects described, i. 152.

Arabians consider the camel as a gift sent from heaven, i. 101.

Perform journies of fifty leagues in one day, *ibid.*

Aranea. See spiders.

Arteries. The probable instruments of nutrition and growth, i. 333.

Artifices. General sources of the artifices of animals, ii. 226.

Artifices of cattle, horses, and monkeys, 227. Of the stag, 228. Of the fallow deer, 229. Of the roebuck, 231. Of the hare, 234. Of the fox, 236. Of the glutton, 240. Of the Kamtschatka rats, 241. Of birds, 243. Of fishes, 245. Of insects, 247.

Albestos. Its structure makes no approach toward organization, i. 19.

Aureliae. See chrysalids.

B Beavers.

B

Beavers. Account of their manners and architecture, ii. 80. Live peaceably in Society with each other, 85. Lay up provisions for winter, 87.

Bees. The general structure of the honey-bee, i. 149. The mason-bee sometimes moves in a retrograde direction, 227, 228. Some of their instincts enumerated, 233. Wood-piercing bee makes a nest in old timber, 234. When pinched for room, they augment the depth of their cells, 239. Nest of the mason-bee, ii. 102. Ichneumon flies destructive to bees, 107. Operations of wood-piercing bees, 108. Of other solitary bees, 115. Operations and oeconomy of the honey-bee, 119. The figure and mode of making their cells, 120. Their cells are destined to answer different purposes, 123. Their division of labour, *ibid.* Their wax a result of a digestive process, 125. Eat the farina of flowers, *ibid.* 126. Require a warm habitation, 128. Mend their hives with propolis, 129. Amass great quantities of honey, 131. Occasionally feed one another, 132. Eggs of the female impregnated by the males after they are deposited in the cells, 134. Can transform a common subject into a queen or female, 138. May be multiplied without end, 141. The neuters massacre the males, 207. Have frequent combats, 208. Their society of a monarchical nature, 264. The Count de Buffon's mechanical theory of the operations of bees examined, 265, &c.

Beetle tribe of insects. An account of their form and manners, i. 140. Many of them, when terrified, simulate death, 237. Remarkable differences between some of the males and females, 381.

Beings should not be contemplated individually, but by their rank, ii. 435, 436. None superior to man could exist in this world, 437.

Birds. Sketch of their structure, i. 100. Their form adapted to their mode of living, 112. Of granivorous birds, 113. Ana-
logy

logy between them and herbivorous quadrupeds, 116. Of carnivorous birds, 117, ii. 195. Birds respire by almost every part of their bodies, and ~~even~~ by the bones, i. 174. One use of this structure, 182. Analogy between birds and fishes, 186. When not restrained, uniformly build nests in the same form, and of the same materials, 236. The great comminuting force of some of their stomachs, 358. Whether the small stones they swallow assist the digestion of their food, 360. Among birds of prey, the females are larger, stronger, and more beautiful, than the males, 383. The reverse takes place among the gallinaceous tribes, *ibid.* Many of them pair, ii. 23, 25. Changes they undergo after being hatched, 40. Of their nidification, 90, 101. Of their artifices, 243. Some of them may be taught articulation, 326. Of their migration, 350, &c. Of their longevity, 412.

Bisons. See oxen.

Blatta. See Cockroach, i. 142.

Blood. Its circulation connected with respiration, i. 168. Showers of it accounted for, ii. 64.

Bones. Birds breathe through them, i. 174.

Brackeleys, a species of the ox, which are taught by the Africans to perform wonderful actions, ii. 325, &c.

Brain. See nerves.

Brain. A short description of it, i. 80. The source of all sensation and motion, 210. Supposed to secrete and distribute the nutritious matter of food, 333.

Breathing. See respiration.

Brutes. See animals.

Bug. Some account of it, i. 143.

Butterflies. Description of them, i. 144. Gave rise to the notion of showers of blood, ii. 64. Void drops of blood, ii. 65.

Cabins. See beavers.

Camel and dromedary, besides four stomachs, have a reservoir for holding water, i. 100. Their manners and dispositions, *ibid.*

Camel-

Camel-cricket. Regarded as a sacred animal, i. 142.

Carnivorous animals. See animals. Their structure adapted to their dispositions, i. 95. Are not so apt to devour women as men, 378. Man the most rapacious of all animals, ii. 186. Of carnivorous quadrupeds, ii. 191. Of carnivorous birds, 195. Of carnivorous insects, 200. Advantages derived from animals preying upon one another, 211. Carnivorous animals are the barriers against noxious inundations of other kinds, 216.

Caterpillars. See insects. Their mode of respiring, i. 196. Are of no sex, 379. When they arrive at the age of puberty, ii. 7. Of their transformations, 44. Cast their skins, 44, 60. Their different modes of retiring previous to their transformation. A description of them, 49. The circulation of their blood changes its direction, 50. Their different modes of behaving when about to transform, 57. Spinning of the silk-worm described, 57, 58. The flies exist in the bodies of the caterpillars, 60. Some of them devour their own species, 202. Have numberless enemies, *ibid.* Without a profusion of them small birds could not be supported, 220. Common kind associate, 271. Some of them are republicans, 277.

Cause. We must at last have recourse to a final cause, ii. 118.

Cells. See bees, and wasps. Air-cells in birds described, i. 175.

Chain. Of the progressive chain of beings, ii. 427.

Changes of form. See transformations.

Characters of animals, ii. 335. How they may be modified, 336. Individual characters often strongly marked, 337.

Chermes. The female of this insect deposits her eggs in the leaves of trees, and produce those protuberances called galls, i. 144.

Children. See infants. The gradual progress of their instincts, ii. 288.

Chrysalids. A description of them, ii. 47.

Cimex. See bug.

Cinyps. A fly whose eggs produce galls in the oak, i. 148.

Cleanliness

- Cleanliness. Its importance to health, i. 206.
- Cock. The game-cock a most intrepid animal, i. 383.
- Cockroach. Some account of it, i. 142.
- Colours. The origin of the primary ones, i. 284. A mixture of them produces whiteness, 285. Colour no specific character of plants, 404, 407. Colours of animals greatly variegated by domestication, ii. 333.
- Coleopterous insects described, i. 139.
- Combs. See bees, and wasps.
- Crabs. An account of the migration of land-crabs, ii. 393.
- Crows. Experiments on their digestive powers, i. 365. Endeavour to break grain before they swallow it, 366.
- Crustaceous fish cast their shells annually, ii. 42.
- Cuckoo makes no nest, and neither hatches nor feeds her young, ii. 97.
- Culex. See gnat.
- Cuttle-fish. Its structure and manners, i. 157.

D

- Death. All animals and vegetables subject to dissolution, i. 63. ii. 36. Life cannot be supported without the intervention of death, 211. There is a wonderful balance in the system of animal destruction and multiplication, 217. The general causes of death, 402.
- Deer. Their artifices in escaping the dogs, ii. 228.
- Deity necessarily one, ii. 436.
- Digestion. The organs of digestion described, 73. The mechanical and chemical theories of it, 354. Viscerals dissolved by the gastric juice, 357. Whether the small stones swallowed by birds assist their digestion, 360. Greatly assisted by chewing, or by comminution, 366. Dr. Stevens's experiments upon digestion in man and other animals, 367. After death, the stomach is dissolved by its own gastric juice, 372. Bees wax a result of digestion, ii. 125.

Dipterous

Dipterous insects described, i. 150.

Docility of animals, ii. 287, &c.

Dog. His sense of smelling extremely acute, i. 259. Wild dogs hunt in packs, ii. 284. Next to the elephant, the dog is the most docile animal, 313. Accommodates his behaviour to the manners of those who command him, 314. Great differences in their natural dispositions, 316. Conduct blind persons with great sagacity, 316. An extraordinary instance of their intelligence, 316, 317. The influence of climate upon them, 332. Fattened in China for the table, 347.

Domestication. Its effects on different animals, ii. 328.

Dragon-fly. See libella.

Dromedary. See camel.

E

Eagles. Their longevity, ii. 415.

Ears. See hearing and senses. Musical ear a gift of Nature, i. 270.

Earth, though spacious, is comparatively small, i. 214.

Education much influenced by the principle of imitation, ii. 343.

Eggs. Analogies between them and the seeds of plants, i. 55. Egg of the spider-fly as large as the mother, ii. 53. Eggs of some insects grow after they are laid, 54. Several worms discovered in the same egg, 56. Eggs of bees impregnated after they are deposited in the cells, 134.

Elephant. His structure, i. 105. His sagacity and manners, 108. A more particular account of this animal, ii. 298. A mild and obedient domestic, 302. Elephants were formerly employed in war, 304. Their sense of smelling very acute, 307. Revengeful when affronted, 309. They are sensible of good fortune, and maintain a gravity of demeanour corresponding to the dignity of their situation, 311. They allow themselves to be commanded by a child, 312. More easily tamed by mildness than by blows, *ibid.*

Ephemeron-

Ephemeron-fly lives only one day in its perfect state, but continues three years in the water before its transformation, i. 141, ii. 420. The nymphs respire by gills, i. 194, 195.

Evils necessary in this world, ii. 436.

Expiration. See respiration.

Eyes. No animal, except the insect tribes, has more than two, i. 132. Description of the eye, 282. Inverted pictures on the retina, 285. Why seen straight, 287, 288. Why we see single with two eyes, 289. Vision conveys no idea of distance, 292. Why near objects appear large, and distant ones small, 293. Origin of ghosts, &c. 293, 294.

F

Fallow-deer. His artifices and manners, ii. 229.

Farina. See plants and sexes. Farina of flowers the raw material of wax, ii. 125.

Feelers of insects. One use of them, i. 131.

Females. See sexes, man, and males. Among insects, great differences between males and females, i. 379, &c. Female birds of prey larger, stronger, and more beautiful than the males, 383. The reverse takes place among gallinaceous birds, *ibid.* Changes in body and mind produced by puberty, ii. 2. Arrive sooner at that period than males, 4.

Fire-fly. Emits a shining light in the night, i. 143.

Fishes. Sketch of their structure, i. 121. Much diversified in figure, 123. Are endowed with the sense of hearing, 125. Their mode of respiration, 183. Analogy between them and birds, 186. We are ignorant of the periods when they become fit for multiplying, ii. 6. Crustaceous kinds cast their skins annually, 42. The life of every fish one continued scene of hostility, 198. Shell-fishes very prolific, 222. Their artifices, 245. Of their migration, 386. Their longevity, 409, 416.

Flea. A description of it, i. 153. Undergoes a transformation like that of winged insects, *ibid.*

Flies.

Flies. See insects. An account of the phrygania or spring-fly, i. 147. Of the dragon-fly, *ibid.* Of the cinyps, the eggs of which give rise to the galls on oak leaves, 148. Gad-fly very troublesome to cattle, 151. Of the common fly, *ibid.* Of the gnat, *ibid.* Spider-fly as large as the mother when it escapes from the egg, i. 351, ii. 53. Some deposit their eggs in the leaves of plants, *ibid.* Ichneumon flies destructive to bees, 107; and other insects, 200.

Food of plants and of animals compared, i. 39. Man could not live upon herbage alone, 93. Food necessary for the growth and expansion of all organised beings, 328. See growth. The general ingredients of food, 339. Rein-deer, the principal food of the Laplanders, 340. Animal food more used in proportion as people recede from the Equator, 342. The nature of man's food determined by the climate, *ibid.* Man designed by Nature to feed partly on animal and partly on vegetable substances, 343, 344. Living long on a particular species of food is apt to create diseases, 346. Diversity of food used by different species one cause of the diffusion of animals over the earth, 347. Every animal furnished with proper instruments for procuring food, 348. Importance of feeding all young animals well, 252. Insects which feed upon carrion never attack live animals, *ibid.* This fact established by experiments, *ibid.* &c. Spalanzani's experiments upon the digestion of food by various animals, 355.

Foramen ovale. In amphibious animals it remains open during life, i. 104.

Formica-leo. Its artifices and manners, ii. 248.

Forms are perpetually changing, ii. 71. See transformations.

Fox. His artifices and manners, ii. 236.

Frogs. Undergo great changes in their form, ii. 41.

Fulgora. See fire-fly.

G

- Gad-fly, extremely troublesome to cattle, both in its caterpillar and fly state, i. 151.
- Gall-insects. Description of their form and manners, i. 379.
- Galls. See chermes. The eggs of the cinyps give rise to those on oak leaves, i. 148. How galls are formed, ii. 54.
- Gastric juice. See digestion and stomach. Its solvent power assisted by chewing, i. 366. No dead animal substance can resist its power, *ibid.*; but it has no effect upon live animals, 369. Dissolves the stomach after death, 372.
- Generation. See multiplication.
- Gentoos. Live almost entirely on vegetables, i. 339. Their casts founded in Nature, ii. 429.
- Germes. Examination of Bonnet's theory of them, i. 337. See growth.
- Glow-worm. See worms.
- Glutton. His artifices and manners, ii. 240.
- Gnat. Account of it, i. 151.
- Goat-sucker, a bird of passage, ii. 357.
- Goose. Its longevity, ii. 413.
- Gordius. See worms, i. 156.
- Granivorous birds. Sketch of their structure, i. 113. Analogous to herbivorous quadrupeds, 116. Their gentle manners, *ibid.*
- Growth of animals and vegetables extremely analogous, i. 38, &c. May be accelerated or retarded by certain circumstances, 45. Buffon's theory of growth, 328. Nutrition supposed to be effected by the brain and nerves, 330. This notion rendered improbable, 331. More probable that the nutritious particles of food are conveyed and applied by the arteries, 333. Bonnet's theory

theory of germs examined, 337. Our limited conceptions of the nature of growth and nourishment, 339. All animals supposed to grow after birth, 351. The spider-fly affords an exception, *ibid.* Remarkable rapidity of growth in some worms, 354. Animals, as well as plants, which quickly arrive at maturity, soon perish, *ii.* 408.

Gryllus. Some account of it, *i.* 142.

Guiney-pig contracts a looseness when forced to eat coleworts for some time, *i.* 346.

H

Habitations of animals. When not restrained, animals uniformly build in the same stile, *ii.* 75. Habitations and manners of the Alpine marmot, 77. Of the beaver, 80, 88. Of the mole, 89. Of birds, 90. Description of the eagle's nest, 92. Of the magpie's nest, 93. Of the titmouse's nest, *ibid.* Of penile nests, 94. Of the nest of the taylor-bird, *ibid.* Nests of small birds, 98. Of water-fowls, 101. Nest of the mason bee, 102. Of the wood-piercing bee, 108. Of another solitary bee, 115. Of the honey bee, 119. Of the wasps, 142. Of the termites or wood-ants, 159. Of the common caterpillar, 272. Of the processionary caterpillar, 274.

Hares. Their artifices in escaping the dogs, *ii.* 234.

Health promoted by moderate laughing, *i.* 172.

Hearing. Fishes endowed with that sense, *i.* 125. The instruments and causes of hearing, 264. Why infants hear bluntly, 268. The pleasures derived from hearing, 271. The source of artificial language, *ibid.*

Heat. See animal heat.

Hemipterous insects. Of their form and manners, *i.* 142.

Herbivorous

Herbivorous quadrupeds. See animals. Their form adapted to their dispositions, i. 90.

Hermaphrodites. Some insects are hermaphrodites, i. 378. Many instances of hermaphrodites among horses, black cattle, and sheep, 384, &c.

Herrings perform extensive migrations, ii. 389.

Hippobosca. See horse-fly.

Hogs associate and defend each other, ii. 284.

Honey-bee. See bees.

Horse-fly. Account of it, i. 152.

Horses. When attacked by any rapacious animal, rank up in lines to defend themselves, ii. 227. One acts as a centinel, *ibid.* Associate with oxen, 285. The gentleness and docility of their dispositions, 318. Notices of wild horses, 320. Naturally associate with man, 321. Their emulation and warlike temper, 322. Their feats in exhibitions, 323.

Hostilities of animals, ii. 184, 186. Man the most rapacious and the most universal destroyer, 186. Of rapacious quadrupeds, 191. Of rapacious birds, 195. Every fish rapacious, 198. Of rapacious insects, 200. Man not the only animal that makes war with his own species, 205. Neuter bees massacre the males, 207. Bees frequently fight with each other, 208. In October, wasps massacre all their young, 209. This seeming cruelty is perhaps an act of mercy, 210. Hostilities of animals give rise to mutual improvement, 213. There is a wonderful balance in the system of animal destruction, 217.

Hottentots. Their mode of training and instructing oxen, ii. 324.

Hunter, Mr. John. His account of the respiration of birds, i. 175. His description of the free-martin, 385.

Hymenopterous insects. Their form and manners, i. 148.

I

Ichneumon flies. See flies and bees,

Imitation. Its effects upon animals as a principle, ii. 343.

Infancy. See infants.

Intellect. The degrees of it extremely varied both among men and other animals, ii. 428.

Infants. They understand language before they can speak, i. 248. Hear bluntly, 268. Are fond of noise, *ibid.* Invent, at the age of nine or twelve months, an artificial language, 273, ii. 14. The condition of human infants considered as miserable, i. 308. This notion invalidated, 309. Fond of motion, 311. The methods of managing them by savages, 313; and by northern nations, 315. Are less affected by cold than at any other period, 317. Their lives very precarious, *ibid.* Causes of their diseases and mortality, 318. Sleep, for several weeks, almost continually, 319. Their memory weak, and why, 320. Duration of infancy in different animals, 321. Infant state of birds short, 322. Infancy of fishes, 323. Of insects, 324. The strong attachment of parents to their young, 325.

Insects. A sketch of their structure, i. 25. A more enlarged view of it, 130. Division of insects from their wings, 131. Use of their feelers, *ibid.* Undergo three changes of form, 133. Some of them endowed with the sense of smelling, 135; and some probably with that of hearing, 137. Account of their proboscis, 138. Of the form and manners of the beetle tribe, 140. Of the form and manners of the hemipterous tribe, 142. Of neuropterous insects, 146. Of hymenopterous insects, 148. Of dipterous insects, 150. Of apterous insects, 152. Of the respiration of insects, 186. Examples of their instincts, 232. Insects have few instincts, 245. Those that feed upon carrion never attack live animals, 252. Great differences between some
male

male and female insects, 379, &c. Description of the form and manners of gall-insects, 379. Insects supposed to impregnate certain plants, 396. Changes they undergo before their age of puberty, ii. 7. Some of them have a strong affection to their young, 19. Of their transformations, 43. Lives of winged insects consist of three principal periods, 51. Their internal parts changed after transformation, *ibid.* The behaviour of different caterpillars when about to transform, 57. Their transformation is only the throwing off temporary coverings, 61. Nests of various insects described, 102. Some of them are rapacious, 201. Thousands of them daily devoured by cattle, 212. Insects afford many instances of association, 264. Some of them migrate, 399. Are short lived, 420.

Inspiration. See respiration.

Instinct. Reasons why it has been so little understood, i. 229. Division of instincts, 230. Of pure instincts, *ibid.* Examples of it in the human species, 231; in the brute creation, 232. Of instincts which can accommodate themselves to peculiar circumstances, 238. Of instincts which are improveable by experience and observation, 241. Superiority of man arises from his great number of instincts, *ibid.* Examples of modified, compounded, or extended instincts, 242. Instinct defined and explained, 244. Insects have few instincts, 245. Instinct presupposes a degree of intellect, ii. 263. The gradual progress of instincts in children, 287. When they begin to reason with some propriety, 288. The education of animals depends greatly on the principle of imitation, 343.

Irritability described, i. 15. Many plants are endowed with this power, 16.

L

Lady-fly. See libella.

Language. Most animals can express their wants and desires, i. 170, 248, 271. Artificial a result of natural language, 271. The origin of the great diversity of languages, 273. Articulate language peculiar to man, ii. 256.

Laplanders. Live chiefly on the rein-deer, i. 340. Fond of bear's flesh, *ibid.*

Laughing described, i. 172. Not peculiar to man, *ibid.*

Legs. No animal, except the insect tribes, have more than four, i. 131.

Libella. A description of it, i. 147. Its nymph respires water, 193. A rapacious animal, ii. 201.

Life. Our ignorance of its essential characteristics, i. 13. Its duration longer or shorter according to the species, 63. Life very precarious in infancy, 317. Lives of winged insects consist of three principal periods, ii. 51. Life cannot be supported without the intervention of death, 212. A profusion of animal life seems to be a general intention of Nature, 215. Of the duration of life in man and other animals, 401, &c. Its duration a relative idea, 425.

Light. Some of its properties, i. 283. Its refrangibility, 285.

Lobsters cast their shells annually, ii. 42.

Longevity of animals, ii. 401. Some remarkable instances of it in the human species, 403; of fishes, 409, 416; of quadrupeds, 412; of a toad, 418; of insects, 420; of plants, 422.

Louse. Its structure and manners, i. 152.

Love.

Love. The source of many important advantages, ii. 9. Is a great incentive to virtue, *ibid.* 10. Bad effects of too early marriages, 11; and of imprudent ones, 12. Love of offspring a source of great pleasures, 14; remarkable instances of its strength, 15, 16, 17, &c. Marriage or pairing frequently exhibited in the brute creation, 23. Most animals have seasons, 28.

Lumbricus. See worms.

Lychnis dioica. Dr. Hope's experiments upon that plant examined, i. 403. Female lychnis ripened seeds without the possibility of sexual commixture, 404, 405.

M

Magpies. Description of their nests, ii. 93.

Males. See sexes, and man. Differences between males and females, i. 379, &c. Changes produced by puberty, ii. 2. In pairing animals, the males and females produced are nearly equal, 24.

Man. Of his structure and organs, i. 168. From his internal organs he could not live upon herbage alone, 93. His superiority over the other animals derived solely from his mental faculties, 96, 160, 242, ii. 188. He alone is endowed with the faculty of articulate speech, i. 171. ii. 256. The most inconsistent of all animals, i. 241. His instincts improveable by observation and experience, 242. Designed by Nature to live partly on animal and partly on vegetable substances, 333, 334. His texture more firm and compact than that of woman, 374. See women. Changes produced by puberty, ii. 2. After puberty, marriage is his natural state, 5. A striking instance of his parental affection, 15. Undergoes many changes in form after birth,

- birth, 36. His mind undergoes changes as well as his body, 38. The most rapacious of all animals, 186. Without society, his powers are limited, 190. Not the only animal that makes war with his own species, 205. The most docile of all animals, 287. His body capable of great exertions, 290. The resemblance of men to particular animals an indication of their dispositions, 339. Of man's longevity and dissolution, 401. No being superior to him could exist in this world, 437.
- Manners and dispositions of animals connected with their form and structure, i. 82, 88, 140, 160.
- Mantis. See camel-cricket.
- Marmot, Alpine. Description of its architecture and manners, ii. 77.
- Marriage, after the age of puberty, is the natural state of man, ii. 5. Disadvantages of too early marriages, 11. Bad effects of interested and imprudent ones, 12. Arguments in favour of monogamy, 23.
- Martin. Mr. Hunter's account of the free-martin, i. 385, &c.
- Martins are birds of passage, ii. 356.
- Mason-bee. See bee.
- Matter. Its *vis inertiae*, i. 209.
- Mechanism inadequate to account for animal action, ii. 117.
- Medusa described, i. 159. Its motions, 224.
- Memory of children is weak, and why, i. 320.
- Metamorphoses. See transformations.
- Migration of animals, ii. 350. Lists of birds of passage, with the times of their arrival and departure, 368, &c. Partial migrations, 379. Principal objects of migration, 380, 399. Men have a principle of migration, 381. Quadrupeds likewise perform partial migrations, 383. Migration of rats, 384; of frogs,

- frogs, 385; of fishes, 386; of land-crabs, 393; of insects, 397.
- Millipedes multiplies by spontaneous separation, i. 48.
- Mind. Its faculties the chief source of animal power, i. 160.
Minds of brutes possessed of original qualities, 244. The lowest species of animals are endowed with minds, 246. The mind of man undergoes changes, ii. 38.
- Minerals, no analogy between them and vegetables, i. 18.
- Modesty. The great defence and ornament of women, i. 376, 377.
Is not confined to the human species, 377.
- Moles. Description of their manners and operations, ii. 89.
- Monkeys. When sleeping, one acts as a centinel, ii. 228.
- Motacilla. See titmouse.
- Moths. An account of them, i. 145. Divided into two kinds, the sphinx and phalaena, *ibid.* All of them, when about to transform, spin cods or clues of silk, ii. 57.
- Motion. Spontaneous motion, i. 208. By what instruments it is performed, 210. Vital and involuntary motions, 211. Motions of animals proportioned to their weight and structure, 213. Motion gives animation and vivacity to the whole scene of Nature, 215. Destructive animals slower in their motions than the weaker kinds, *ibid.* Progressive motion of the muscle, 217. Motions of the razor or spout fish, 219; of the scallop, 221; of the oyster, 222; of the sea-urchin, 223; of the medusa, or sea-nettle, 224. Motion of the mason-bee sometimes retrograde, 227. The rate at which sound moves, 267. Children derive great happiness from motion, 312.
- Mouflon, the original stock of the sheep, ii. 329.
- Multiplication. The hydra of Linnaeus multiplies by sending off shoots from its body, i. 47. The bell-polypus multiplies by splitting longitudinally, *ibid.*; and the funnel-shaped polypus by splitting transversely, 48. The dart-millepes likewise multiplies
by

by spontaneous separation, *ibid.* Infusion-animalcules multiply by continued divisions and subdivisions, 49. Puceron multiplies without impregnation, 52. A profusion of animal life one great intention of Nature, *ii.* 215. Noxious multiplication restrained by various causes, 217, 218.

Musca. See flies.

Muscles. Their progressive motion described, *i.* 217.

Muscles. The instruments of animal motion, *i.* 210.

Musical ears. See ears.

N

Nature, in the formation of animals and vegetables, seems to have acted upon the same general plan, *i.* 17. Her intentions in changing forms, *ii.* 72. If properly understood, her intentions are never wrong, 210. Seems to pay little attention to individuals, but uniformly supports the species, 211. Advantages derived from her allowing animals to prey on one another, *ibid.* &c. It gives rise to mutual improvement, 213. A profusion of animal life seems to be a general intention of Nature, 215. There is a wonderful balance in the system of animal destruction, 217. Nature observes a uniform gradation of beings, 427.

Nerves. A short description of them, *i.* 79. The source of all sensation and motion, 211, 255, 277. Their papillae the immediate instruments of sensation, 277.

Nests. See birds and habitations. Pensile nests, *ii.* 94. Curious nest of the taylor-bird, *ibid.* Cuckow makes none, 97. Nests of different birds, 98. Nests of various insects, 102. Wasp's nest described, 142. Nests or hills of the termites, 159; of caterpillars, 272.

Nettle. Sea-nettle's motions extremely slow, *i.* 224.

Neuropterous

Neuropterous insects. Description of them, i. 146.

Nidification. See birds.

Nose. Description of that organ, i. 255.

Nutrition. See food, growth.

Nymphs. A description of them, ii. 49.

Q

Oak. Account of a remarkable one, ii. 422.

Ocean. It produces the largest animals now known, i. 124.

Odours. The reason why they excite the sense of smelling, i. 256.

The particles of odorous bodies extremely minute, 258.

Oestrus. See gad-fly.

Orang-outang. His form as well as his manners make the nearest approach to those of man, i. 83. Walks erect, 95. An account of the imitative powers of what is called the larger and smaller species, ii. 291. Their manners, 291, 292, 293. Belong not to the human kind, 297. Nearly allied to man, 291.

Organs. See animals, birds, quadrupeds, fishes, plants, and structure.

Ostrich vindicated from unnaturality, i. 239.

Ox-eye. See titmouse.

Oxen dull and phlegmatic animals, but capable of instruction, ii. 323, 324. Much changed by domestication, 333.

Oyster. Its motions described, i. 222. Is endowed with some degree of intelligence, *ibid.*

P Pairing.

P

Pairing. See marriage. Many animals pair, ii. 23, 24.

Palm-tree. Its mode of culture in Arabia no proof of the sexes of plants. See sexes.

Palpi of insects described, i. 135.

Papillae. See nerves.

Papilio. See butterfly.

Parental affection. See love.

Pediculus. See louse.

Pelican. Her mode of supplying her young with drink, i. 348.

Phalaena. See moth.

Phryganea. See flies.

Pies. Their nests very various, ii. 93.

Pilchards. See herrings.

Plants. Difficulty of distinguishing them from animals, i. 2. Definitions of them by Jungius, *ibid.*; by Ludwig, 3; by Linnaeus, *ibid.* Examples of the motions of plants, 6—11. Their whole structure may be considered as a stomach for receiving their food, 11. Other examples of vegetable movements, 10—12. Many of them have the power of irritability, 15. Between vegetables and minerals there is hardly any analogy, 18. Analogies between animals and plants, originating from their structure and organs, 22—38. Sketch of the structure of plants, 28—32. Their oeconomy and functions are results of a vascular texture, 32. Analogies arising from their growth and nourishment, 38—46. Food of plants and of animals compared, 39. Analogies between the animal and vegetable derived

derived from their dissemination and decay, 46, &c. Analogies between the eggs of animals and the seeds of plants, 55. Some plants may be considered as viviparous, 58. Plants have their seasons as well as animals, 61. All are subject to many diseases, and at last to individual dissolution, 63. Of the supposed sexes of plants, 388. See sexes. Pollen or farina of plants supposed to be analogous to the male organs of generation, 391. New varieties of plants often proceed from accidental causes, 400, 401. Plants, as well as animals, undergo transformations, ii. 67. See transformations. Those which grow quickly soon perish, 408. Their longevity, 422.

Pollen. See plants, and sexes.

Polypus. Description of its structure and mode of multiplying, i. 26. When cut to pieces in any direction, each section soon becomes a perfect animal, 27. One species may be engrafted upon another, 28. Some polypi multiply by splitting longitudinally, and others transversely, 47, 48. Connects the animal to the vegetable kingdom, ii. 433.

Proboscis of insects described, i. 138.

Propolis, or bee-glue. See bees.

Puberty. This period of life arrives later, or more early, according to the difference of species, i. 42. Of the puberty of animals in general, ii. 1. Changes produced by it, 2—8. Females arrive sooner at that period than males, 4. All animals undergo changes at the age of puberty, 5.

Pucerons. Some species are both viviparous and oviparous, i. 52. Can produce without impregnation, 54, 144. Differences between the males and females, 382. Devoured by numberless enemies, ii. 204.

Pulex. See flea.

Q Quadrupeds.

Q

Quadrupeds. Their structure, i. 82. The similarity of their structure and organs to those of man, 83. Of the carnivorous kinds, 88. Of the herbivorous, 90. Few quadrupeds pair, ii. 28. Undergo changes of form after birth, 37. Their mental powers likewise change, *ibid.* Some of them construct habitations, 75. Of carnivorous quadrupeds, 187. Their discriminating characters, 338, 339. Some of them migrate, 383. Of their longevity, 412.

Quails. Of their migration, ii. 356.

R

Rapacious. See carnivorous.

Rats of Kamtschatka Their artifices and manners, ii. 241.

Ravens. Their mode of breaking shell-fishes, ii. 244. Their longevity, 414.

Razor-fish. See spout-fish.

Rein-deer, the chief food of the Laplanders, i. 340.

Respiration. Air necessary to the existence of all animal and vegetable bodies, i. 162. The mode in which respiration is carried on by man and the larger land animals, *ibid.* Dr. Crawford has rendered it probable that respiration is the cause of animal heat, 164. Connected with the circulation of the blood, 168. Commences instantly after birth, and continues during life, 169. Of laughing, 172. Of weeping, *ibid.* Many secondary advantages derived from respiration, 174. Birds
respire

respire by the bones, and almost every part of the body, as well as by the lungs, 175. Respiration of fishes, 183. Respiration of insects, 186.

Retina. External objects painted on it in an inverted position, i. 285. Why objects are seen erect notwithstanding the inversion of the pictures, 287, 288. Why vision is single though a picture is painted on each eye, 289.

Roebuck. His artifices and manners, ii. 231.

S

Saliva, a powerful solvent, i. 261.

Salmons. Of their migrations, &c. ii. 386.

Scale. Of the progressive scale of beings, ii. 427, &c.

Scallop. Its motions described, i. 221.

Scarabaei, or the beetle tribe of insects, an account of them, i. 140.

Scorpion. Account of it, i. 155.

Sea-nettle capable of being ingrafted, i. 63.

Seal. Sketch of his manners, i. 104.

Seasons. See love.

Seeds. Analogies between them and the eggs of animals, i. 55.

Seeing. See senses.

Sensation implies the perception of pleasure and pain. May be suspended without death, i. 12. See senses. Theory of sensation, 277.

Senses. Fishes endowed with the sense of hearing, i. 125. Of the senses in general, 253. Of the sense of smelling, 255. Men, as well as brutes, assisted in the selection of food by the sense

sense of smelling, 256. Most odours productive either of pleasure or pain, 259. The sense of smelling in some animals remarkably acute, *ibid.* Of tasting, 260. The organs of taste and smelling assist each other, 261. Sense of tasting comparatively gross, 262. Sense of hearing, 264. The pleasures derived from it, 271. Sense of touch, 275. Sense of seeing, 281, conveys no idea of distance, 292. Errors of vision corrected by touch, 296. Of the sense of smelling alone, 296; of hearing alone, 298; of smelling and hearing united, 299; of taste alone, and united with smelling and hearing, 300; of sight alone, *ibid.*; of sight united with smell, hearing, and taste, 301; of touching alone, 302; of touch united with smelling, 305; of hearing, taste, and touch united, 306. Of sight united with all the other senses, *ibid.*

Sepia. See cuttle-fish.

Serpents cast their skins annually, *ii.* 43.

Sexes. Of the sexes of animals, *i.* 374. Their intercourse not always necessary for multiplication, 378. See multiplication. Caterpillars are of no sex, 379. Among the larger animals, the difference of size between males and females is not considerable, *ibid.*; but, among insects, the difference often great, *ibid.* 380, 381. Of the supposed sexes of plants, 388. The arguments employed to support the sexes of plants are entirely analogical, 389. These analogies shown to be without foundation, *ibid.* 390. Some of them ridiculous, 393. The most plausible argument in support of vegetable sexes derived from the culture of the date-bearing palm, *ibid.* This circumstance brings no aid to the sexualist, 394. Mylius's experiment on the Berlin palm imperfect and inconclusive, 394, 395. Sexualists have recourse to the winds and to insects for the impregnation of certain plants, 396. This notion refuted, 398, 399. Argument from new varieties examined, 400. Dr. Hope's experiments on the *lychnis dioica* examined, 402. Spalanzani's experiments

experiments on the sexes of plants, 400—416. Changes produced in animals by puberty, ii. 2. The male bees impregnate the eggs after they are deposited in the cells, 134.

Sheep associate, and defend each other, ii. 284. Their origin, 329.

Showers of blood accounted for, ii. 65.

Silk-worms. See worms and caterpillars.

Skeletons, of all quadrupeds, when raised on their hind-legs, have a great resemblance to those of man, i. 84.

Sleep of plants, i. 9.

Smeathman. His account of the termites or wood-ants, i. 159.

Smelling. See senses.

Snails. Their mode of respiring, i. 199.

Society. Not confined to the human species, ii. 252. Its origin, *ibid.* The associating principle is instinctive, 254. Its advantages, 256. Gives rise to many virtues and sources of happiness, 257. Its disadvantages, 258. Without association, men could perform no extensive operations, *ibid.* Society of the beavers, 260; of pairing birds, 262; of the honey-bees, 264; of the common caterpillars, 272; of the processionary caterpillars, 274. Some caterpillars are republicans, 277. Society of ants, 280; of gregarious animals who carry on no common operations, 282.

Sound. Its medium and causes, i. 265. The celerity of its motion, 267. Augmented by reflection, 268. Its modifications, *ibid.*

Spalanzani. Account of his experiments upon digestion, i. 357. His experiments on the sexes of plants, 410.

Sparrows of great use by devouring numbers of caterpillars, ii. 220.

Speech. See language.

Sphinx. See moth.

Spiders. Their structure and manners, i. 154. When terrified simulate death, 237. Their attachment to their young, ii. 17. Most voracious animals, 200. Some survive the winter, 247.

Spider-fly. See flies, and growth.

Spout-fish. Its motions described, i. 219. Comes above the sand upon putting salt on the mouth of its habitation, 220.

Stag. His artifices in escaping the dogs, ii. 228. Form herds, 283.

Stevens (Dr.). His experiments on digestion performed by means of a German who was in the habit of swallowing stones, i. 367.

Stigmata of insects described, and their uses, i. 187.

Stomach. Every part of vegetables may be considered as a stomach, i. 11. In carnivorous animals, the stomach is proportionally small, 88. Its juice dissolves all kinds of victuals, 357. Its great comminuting force in certain birds, 366, &c. In man and quadrupeds, the stomach seems not to act upon its contents, which are totally dissolved by the gastric juice, *ibid.* See gastric juice. After death, the gastric juice dissolves the stomach, 372.

Storks clear Egypt of serpents, frogs, mice, &c. ii. 219.

Structure and organs. Their connection with manners and dispositions, i. 82, 88, 140, 160. Structure of quadrupeds has a great resemblance to that of man, 83. Structure of birds, 110. Structure of fishes, 121. Structure of insects, 130.

Swallow. A curious instinct of it, i. 236. Swallow's nests, ii. 100. Of their migration and torpidity, 350, &c. Different opinions on this subject examined, 358. Could not possibly exist under water, 362.

Swans. Their longevity, ii. 413.

Sword-fish often kills the whale, ii. 223.

T

Tadpole. See frogs.

Tailed men have no existence, ii. 432.

Taste. See senses. The instruments and causes of the sensation of tasting, i. 261. Taste various in individuals of the same species, 263.

Taylor-bird. Description of its wonderful nest, ii. 94.

Termites. Mr. Smeathman's description of their singular operations, ii. 159. Description of these animals, 160. Undergo great changes in form, *ibid.* 161, 162. Wonderful prolific powers of the females, 165. Their nests or hills described, 167. Of their royal chamber, 169. Of their nurseries, 171. Of their magazines, 174. Of their subterraneous passages, 175. Of their warlike dispositions, 177. Repair their habitations, 178.

Tiger. His dispositions are grossly ferocious, ii. 191.

Tit-mouse. Description of its nest, ii. 93.

Toads. Instances of their being found alive in the heart of trees, and inclosed in solid stones, i. 201, 202. Their longevity, ii. 418.

Tongue and palate, the principal instruments of the sense of tasting, i. 261.

Touch. See senses.

Tracheae of insects described, and their uses, i. 187.

Transformations. Every animal undergoes changes, ii. 36, &c.

Transformation of frogs, 41. Crustaceous animals cast their shells annually, 42. Serpents annually cast their skins, 43. Of the transformations of insects, *ibid.* Transformation of the silk-worm, 45; of other caterpillars, *ibid.* The internal parts,

as well as the external form, of winged insects undergo considerable changes, 51. Spider-fly transformed into a chrysalis before escaping the belly of its mother, 52. The behaviour of different caterpillars when about to transform, 57. Transformation of insects is only the throwing off of temporary coverings, 61. Plants, as well as animals, undergo transformations, 67. Intentions of Nature in changing forms, 72.

Trochus destroys numbers of shell-fishes, ii. 222.

Turkey. The great comminuting force of its stomach, i. 359.

U

Urchin. Motions of the sea urchin described, i. 223.

V

Vacuum. Sounds cannot be propagated through it, i. 265.

Vegetables. See plants.

Vermes. See worms.

Vis inertiae defined, i. 209.

Vision. See eyes and retina.

W

War. Man not the only animal that makes war with its own species, ii. 206.

Wasp. Solitary wasp digs holes in the sand, where she deposits her eggs, i. 235. Feed their young by disgorging like the pigeon, ii. 18. Their manners and operations, 142. Their cells composed of paper, 143. Description of their nest, *ibid*. Their manner of building, 147. Republics of wasps consist of males, females, and neuters, 150. Description of the different kinds, 154. Massacre their young, 209.

Wax.

- Wax. Bees wax a result of a digestive process, ii. 125.
- Weeping, how performed, and its effects, i. 172. Not peculiar to man, *ibid.*
- Whales often killed by the sword-fish, ii. 223.
- Winds. Supposed to impregnate certain plants, i. 396. This notion refuted, 397, 398.
- Wings. No animal, except insects, have more than two, i. 133. Those of insects made the foundation of a methodical distribution, 139.
- Wolf. His dispositions are fierce and rapacious, ii. 193, 194.
- Women. Their texture more lax than that of man, i. 374. Their minds are likewise more timid, *ibid.* Social intercourse with them softens the dispositions of men, 375. Modesty the great ornament of women, *ibid.* Carnivorous quadrupeds not so apt to devour women as men, 378. See multiplication, and sexes.
- Wood-ants. See ants and termites.
- Wood-pecker. Some account of it, ii. 244.
- Worms. Account of these insects, i. 155. Of the hair-worm, 156. Of the earth-worm, *ibid.* Rat-tailed worms, their mode of respiring air, 188. In some worms, the rapidity of their growth is remarkable, 354. Account of the male and female glow-worm, 381. Silk-worms spin pods before their transformation into flies, ii. 45. See caterpillars. Instances of several worms proceeding from one egg, 57. The manner in which the silk-worms spin their cod or clue, 57, 58.

